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Chapter 1: Introduction to the Mass Storage System

The mass storage system at Fermilab has three major components:

- Enstore, the principal mass storage component; Enstore provides access to data on tape or other storage media both local to a user's machine and over networks.
- A namespace (implemented by PNFS), which presents the storage media library contents as though the data files existed in a hierarchical UNIX file system.
- dCache, a data file caching system; dCache is implemented as a front-end to Enstore.

1.1 About Enstore

Enstore is the mass storage system implemented at Fermilab as the primary data store for large data sets. Its design was inspired by the mass storage architecture at DESY, and it originates from discussions with the DESY designers. Enstore is designed to provide high fault tolerance and availability sufficient for the RunII data acquisition needs, as well as easy administration and monitoring. It uses a client-server architecture which provides a generic interface for users and allows for hardware and software components that can be replaced and/or expanded.

Enstore has two major kinds of software components:

- the Enstore servers, which are software modules that have specific functions, e.g., maintain database of data files, maintain database of storage volumes, maintain configuration, look for error conditions and sound alarms, communicate user requests down the chain to the tape robots, and so on. See Chapter 8: *Overview of the Enstore Servers*.
- **encp**, a program for copying files directly to and from the mass storage system. See Chapter 6: *Copying Files with Encp*

Enstore can be used directly only from on-site machines. Off-site users are restricted to accessing Enstore via dCache, and in fact on-site users are encouraged to go through dCache as well.

Enstore supports both automated and manual storage media libraries. It allows for a larger number of storage volumes than slots. It also allows for simultaneous access to multiple volumes through automated media libraries. There is no preset upper limit to the size of a data file in the enstore system; the actual size is limited by the physical resources. The lower limit on the file size is zero. The upper limit on the number of files that can be stored on a single volume is about 5000.

Enstore allows users to search and list contents of media volumes as easily as they search native file systems. The stored files appear to the user as though they exist in a mounted UNIX directory. The mounted directory is actually a distributed virtual file system in PNFS namespace containing metadata for each stored file. Enstore eliminates the need to know volume names or other details about the actual file storage.

Users typically access Enstore via the dCache caching system. The protocols supported by dCache include dccp, gridftp (globus-url-copy), kerberized ftp and weakly-authenticated ftp (these are described in Chapter 5: *Using the dCache to Copy Files to/from Enstore*). On-site users may bypass dCache and use the **encp** program, the Enstore copy command roughly modeled on UNIX's **cp**, to copy files directly to and from storage media.

There are several installed Enstore systems at Fermilab. Currently these include CDFEN for CDF RunII, D0EN for D0 RunII, and STKEN for all other Fermilab users. Web-based monitoring for the Enstore systems is available at **`http://hppc.fnal.gov/enstore/`**. Currently, all storage libraries are tape libraries. The Computing Division operates and maintains the tape robots, slots, and other tape equipment, but for the present, experiments provide and manage their own volumes.

1.2 PNFS Namespace

PNFS is a virtual file system package that implements the Enstore namespace. It was written at DESY. PNFS is mounted like NFS, but it is a virtual file system only. It maintains file grouping and structure information via a set of tags in each directory. The **encp** program communicates this information between PNFS and the Enstore servers when it uploads or downloads a data file.

PNFS can only be mounted on machines that are physically at the lab[1]. When a user copies a data file from disk to the Enstore system, he or she specifies its destination in terms of a PNFS directory. The data file gets copied to a storage volume (selected according to the tags of the specified PNFS directory) and a corresponding metadata entry is created in the PNFS directory. This entry takes the name given in the **encp** command line or in the protocol-specific dCache command. It contains metadata about the data file, including information about the file transfer, the data storage volume on which the data file resides, the file's location on the volume, and so on.

To browse file entries in the Enstore system, on-site users can mount their experiment's PNFS storage area on their own computers, and interact with it using standard non-I/O UNIX operating system utilities (see section 4.1 *UNIX*

1 There are some exceptions; arrangements for PNFS mounting have been made for some experiments whose systems are managed by the Computing Division, e.g., soudan.org for Minos.

Commands You can Use in PNFS Space). Normal UNIX permissions and administered export points are used for preventing unauthorized access to the name space.

1.3 dCache

1.3.1 Overview

The dCache was originally designed as a front-end for a set of Hierarchical Storage Managers (HSMs), namely Enstore, EuroGate and DESY's OSM. (It has since been further developed and can be implemented stand-alone. We do not address the stand-alone functionality in this manual.) When used as a front-end to an HSM, dCache can be viewed as an intermediate "relay station" between client applications and the HSM (Enstore, in our case). Client systems communicate with dCache via any of a number of protocols, listed in Error: Reference source not found. DCache communicates with Enstore (in a manner transparent to the user) via a high-speed ethernet connection. The dCache decouples the potentially slow network transfer (to and from client machines) from the fast storage media I/O in order to keep Enstore from bogging down.

Data files uploaded to the dCache from a user's machine are stored on highly reliable RAID disks pending transfer to Enstore. Files already written to storage media that get downloaded to the dCache from Enstore are stored on ordinary disks.

The dCache is installed at Fermilab on a server machine on which the **`/pnfs`** root area is mounted. Since PNFS namespace can only be mounted on machines in the fnal.gov domain, off-site users may only access Enstore via the dCache. On-site users are strongly encouraged to go through the dCache as well. We discuss dCache in more depth in Chapter 5: *Using the dCache to Copy Files to/from Enstore*.

Read more general information about the dCache at the DESY site: **`http://www-dcache.desy.de`**.

1.3.2 Advantages

The principal advantages of using the dCache are:

- Optimized usage of existing tape drives due to transfer rate adaption.
- Possible usage of slower and cheaper drive technology without overall performance reduction.
- Optimized usage of the robot systems by coordinated read and write requests.
- Better usage of network bandwidth by exploring the best location for the data.

- No explicit staging required to access the data.
- Ability to do posix-like IO reads and writes to data files instead of transferring entire files.
- Working ROOT interfaces.
- Tapeless data methods, raw data to reconstruction to analysis to users.
- Written to tape as 'by-product'; no tape delays.
- Pnfs does not have to be mounted for access to the data.
- Same access to storage system, on and off site. Strong authentication, both gss and gsi to the data. Native and ftp access to the data.
- The access methods for data would be uniform, independent of data's media location.
- Even without the back-end HSM (e.g., Enstore), the dCache system could be seen as a huge data store with a unique namespace and standardized access methods. Care will be taken that valuable data resides on safe disks as long as no HSM copy exists. Back-end storage to the HSM can be done regularly (policy based) or by manual intervention only.
- A joint DESY-FNAL effort makes the use of manpower more efficient and guarantees continued support and maintenance of the developed software.

1.3.3 Protocols for Communicating with dCache

Whenever an application needs to talk to the dCache, it has to choose an appropriate *door* into the system. There are a number of different dCache doors through which users/applications can send requests to Enstore. Doors are protocol converters from the dCache point of view, and they are responsible for strong authentication, as necessary. One door may be for Kerberized ftp read/write access, another for dcap (dCache native C API), gridftp, weakly authenticated ftp read-only access, and so on. Each experiment determines which door(s) its experimenters may use, and communicates this information to the Enstore administrators who manage the doors' configurations. Most doors are for native transfers, and are local. See Chapter 5: *Using the dCache to Copy Files to/from Enstore* for more information.

Chapter 2: Data Storage in Enstore

2.1 Storage Groups

Each experiment or research project is assigned a unique *storage group* identifier by the Enstore administrators. Enstore uses the storage group names to control and balance assignment of resources, such as tape drives and media, among the experiments. Each storage group is assigned an area in PNFS, e.g., an experiment XYZ might be assigned the storage area `/pnfs/xyz`.

2.2 File Organization on Storage Media

2.2.1 File Family

Files are grouped on data storage volumes according to a *file family*[2] attribute. A file family is a name that defines a category, or family, of data files. Each experiment (i.e., each storage group) must carefully plan its set of file families. There may be many file families configured; by design there is no pre-set upper limit on the number. A given storage volume may only contain files belonging to one file family.

Every directory in `/pnfs` namespace has a file family associated with it. Every data file added to the Enstore system (i.e., every file for which an entry appears in the `/pnfs` namespace) is thus associated with the file family of the directory under `/pnfs` into which it was initially copied.

Associated with a file family are a *file family width* (an integer value), and a *file family wrapper* (a format specification). The file family, file family width, and file family wrapper for a PNFS directory are initially inherited from the parent directory. They may be reset as permissions allow, generally only by a small group of designated people in each experiment.

2.2.2 File Family Width

File family width is an integer value associated with a file family that is used to limit write-accessiblity on data storage volumes. There is currently no width associated with reading. For a given media type and for a given file family, Enstore limits the number of volumes available for writing at any given time to the value of the file family width (except when unfilled volumes

2 The grouping is really based on the triplet of quantities: storage group + file family + wrapper, collectively called a "volume family". However, most users have access to only one storage group, and use the default wrapper, so from the user's perspective, the only relevant attribute for file grouping is file family, typically.

are already mounted for previous reads). Correspondingly, the number of media drives on which the volumes are loaded is also limited to the width.

2.2.3 File Family Wrapper

A file family wrapper specifies the format of files on the storage volume. It defines information that gets added before and after data files as they're written to media. In this way the data written to tape is self-contained and independent of metadata stored externally.
There are three wrapper types implemented, `cpio_odc`, `cern` and `null`. Currently (September 2005) most tapes are written using the `cpio_odc` wrapper. The `cpio_odc` wrapper is the default wrapper set up by the Enstore admin when a new PNFS area is created.

- All files with the `cpio_odc` wrapper are dumpable via **`cpio`**. This wrapper has a file length limit of (8G – 1) bytes. It is sufficient for the vast majority of data files, as most files are still under 2GB.
- The `cern` wrapper accommodates data files up to (10^21 –1) bytes, which in effect limits the filesize to the tape length, since spanning and striping are not supported as explained in section Error: Reference source not found. It matches an extension to the ANSI standard, as proposed by CERN, and allows data files written at Fermilab to be readable by CERN, and vice-versa[3].
- For NULL volumes there is a `null` wrapper. See section 6.5.8 *NULL File Directories* for other restrictions on using NULL volumes.[4]

2.3 File Size Limitations

Enstore limits the size of a data file to the tape capacity, i.e., a single file cannot span more than one volume. The `cpio_odc` wrapper further limits the file size to (8G – 1) bytes, as mentioned in section Error: Reference source not found. Your OS may restrict your files to yet a smaller size.
Tape sizes are as follows (all sizes shown are for non-compressed tapes):

T10000D	8 TB
T10000C	5 TB
LTO-4	800 GB

3 Since CERN will allow files to span volumes, and Fermilab doesn't, users will not be able to use Enstore to read volumes from the CERN system that contain partial files.

4 On rare occasions the Enstore administrator may determine that the null wrapper should be used for tapes written elsewhere and imported into Enstore.

LTO-3	400 GB
LTO-2	200 GB (no longer used)
LTO-1	100 GB (no longer used)
9940B	200 GB
9940	60 GB
9840	20 GB (no longer used)
DECDLT (4000)	20 GB Compressed (Special read-only situation)
Mammoth 2	60 GB (no longer used)
Mammoth	20 GB (no longer used)

Wrapper size limitations are as follows:

cpio_odc	8 GB -1B; (about $8*10^9$ Bytes)
cern	About 10^{12} GB; or 86.7 Exabytes; (10^{21}-1 Bytes)
null	N/A; not available for writing to tapes; used for special situations

☞Note: PNFS can only represent a data file's size accurately up to (2G–1)B; beyond that, the file size is shown as 1. Enstore knows, stores and uses the real file size, so this PNFS display limitation does not pose a functionality problem. A 1 byte file size indicated by PNFS indicates to the the user that the file is likely quite large. (You can use the **`enstore pnfs`** command with the **`--filesize`** option as described 1under section 9.4 *enstore pnfs* to find the actual file size.)

2.4 Data Storage Volumes in Enstore

Enstore is designed to support a variety of data storage media. Currently, only tapes have been implemented, and the information in this section has been written with tapes in mind. In principle, the information should apply equally to other media types; we will update this section as necessary when other media types are implemented.

2.4.1 Tape Features

Tapes are self-describing and exportable so that in the unlikely event of lost metadata in Enstore, a volume can be dumped, and the information retrieved. Tapes are required to have ANSI Vol1 header labels. Labeling helps to easily identify each volume and/or test for a blank one, thereby inhibiting the inadvertent overwriting of used tapes. The Enstore administrators needs to know whether tapes are labeled or completely blank when they are inserted into the library; the Enstore software can label tapes if necessary.

2.4.2 Tape and Library (Robot) Lifetimes

Over time ware and tear can damage the magnetic tape. This translates into an expected number of tape mounts before problems may start to occur. Eventually, these files are migrated to another tape, hopefully before any problems appear. The old tapes are then taken out of service. There are two limits. A soft limit where the files on a tape with more than that many mounts should be migrated, but it is not urgent to do so. A tape with more that the hard limit of mounts should be migrated as soon as possible.

Tape Type	Soft Limit	Hard Limit
T10000T2	23,000	25,000
T10000	10,000	15,000
LTO-4	10,000	15,000
LTO-3	10,000	15,000
LTO-2	2,000	5,000
LTO-1	2,000	5,000
9940B	2,000	5,000
9940	2,000	5,000
9840	2,000	5,000
DECDLT (4000)	2,000	5,000
Mammoth 2	2,000	5,000
Mammoth	2,000	5,000

Over time tape libraries (also known as tape robots) become obsolete. Files on tapes inside soon-to-be-decommissioned tape libraries will also need to be migrated. By default Enstore administrators will preserve deleted files on tape while migrating; though groups may be asked if .deleted files can be skipped during the migration process.

2.4.3 File Organization, Storage and Access

Data files are physically clustered on volumes according to each experiment's file family classification scheme. A given volume may only contain files belonging to one file family, one wrapper type, and one storage group.
A single file cannot span more than one volume[5]. When writing files to media, Enstore compares the size of the file it's ready to copy against the volume's remaining empty space in order to determine whether the file will fit. If the file is too large to fit, Enstore marks the volume as full, and writes the file to a different volume. Thus volumes are filled, modulo some fraction of a data file. (Volumes can be reopened if an administrator decides that too much space is left unused.)
Enstore supports random access of files on storage volumes, and also *streaming*, the sequential access of adjacent files.

2.4.4 Quantity of Volumes

Enstore allows data storage volumes to be "faulted out to shelf", i.e., removed from a robot. This feature makes it possible for each experiment to have a larger number of volumes than it has slots in the robot, and in fact there is no limit on the number of volumes used by an experiment. To accommodate the unmatched numbers of volumes and slots, Enstore provides separate quotas in volumes and in slots.
Note that moving volumes in and out of the robot requires operator intervention, and should be minimized.

2.4.5 Import/Export of Volumes

Tapes can be generated outside the Enstore system and imported into it. Conversely, Enstore tapes can be dumped via standard UNIX utilities, thereby allowing them to be readable with simple tools outside the Enstore framework. The tools to do this are wrapper-dependent (e.g., tapes whose files have the cpio wrapper can be dumped via the **`cpio`** utility). Currently there is no utility (except **`dd`**) to dump a tape whose file family wrapper is

5 Since files cannot span multiple volumes, striping is not supported either. Striping refers to files (usually large ones) being split onto two or more volumes, each writing simultaneously, in order to expedite the writing process.

cern.

Chapter 3: Getting Ready to Use Enstore and dCache

3.1 Initial Steps for All Users

1. Find out what your volume quota is from your experiment's Enstore administrator, and make sure you reserve what you need, according to your experiment's procedures. The experiment's Enstore liaison should use the online form *STKEN Mass Storage Request Form* at `http://computing.fnal.gov/cd/forms/storagerequest.html` to request quota for the experiment.
2. Find out what area in `/pnfs` namespace your experiment uses.
3. Read about file families (see section 2.2.1 *File Family*), and find out from the people in your experiment responsible for implementing Enstore how file families have been configured for your experiment. Determine what file family(ies), and hence which subdirectories in `/pnfs` namespace, you want to write to and/or read from.
4. Encp and Enstore commands use whatever routing the client system or network administrator sets between the client system and the Enstore system for data transfers. If you (as the sysadmin or network admin of the large client machine) want to restrict the set of interfaces that encp/Enstore uses, you need to create the file `enstore.conf`. This file controls the interface-router mapping for the network connections used by encp/Enstore. For information and instructions, see Appendix A: *Network Control.*
5. Navigate to the Enstore monitoring system web page, titled *Fermilab Mass Storage System*, at `http://hppc.fnal.gov/enstore/`. Select the Enstore system that your experiment uses, and browse the system information for it. You might want to bookmark this page.
6. Subscribe to the *stk-users@fnal.gov* listserv mailing list for announcments about Enstore and the STKEN Enstore system. D0 users, subscribe to *d0en-announce@fnal.gov*. CDF users, subscribe to *cdfdh_oper@fnal.gov*.

☞ Note:

- Data are moved with the default TCP window size on the machine. There is a potential for an extreme performance degradation if the default window is set too large. A value of about 32K works well at most locations at Fermilab.

3.2 Further Steps for Direct Access Enstore Users Only

If you access Enstore through dCache, this section doesn't pertain to you.

1. Make sure your node and network can provide adequate throughput. To determine the optimal data transfer rate, consult the Enstore administrators.
2. See if your experiment's `/pnfs` area is mounted on your machine, by using standard UNIX utilities like **`cd`** and **`ls`**. If it's already mounted, skip to step (6). If not, continue.
3. Check to see if authorization has been granted to mount the `/pnfs` area on the machine you plan to use. To do so:
   a) Go to the *PNFS Exports Page*[6], at `http://www-<xyz>en.fnal.gov:/enstore/pnfsExports.html`, where `<xyz>` is one of `stk`, `d0` or `cdf`, depending on the Enstore system used by your experiment.
   b) Scroll down to the *PNFS ExportList Fetch Begin: <date/time>* area, and look for your node and `/pnfs/storage-group` area. If they're listed, authorization has been granted; skip to (5). If not, continue.
4. Notify your experiment's Enstore liaison that you need authorization to mount the `/pnfs` area on the machine you plan to use. He or she will need to send your request on to *enstore-admin@fnal.gov*.
5. Once authorization has been granted, mount the `/pnfs` area on your machine if you have root permission, or send a request to the machine's system administrator to mount it. To mount the area yourself, edit the `/etc/fstab` file and add a line with the following strings (they should appear all on the same line in the file; we separate them into six lines here for clarity):

```
remote_enstore_server_node:enstore_server_directory
/pnfs/local_mount_point
mount type
comma_separated_attributes
0
0
```

where the 0 in the 2nd-to-last line means no dump of filesystem, and

6 Note that you can also get to the *PNFS Exports Page* from the *Fermilab Mass Storage System* web page at `http://hppc.fnal.gov/enstore/` via the following path: Under *Installed Enstore Systems*, click the system your experiment is using. On the *Enstore System Status* page, click "Log Files". Under *User Specified Log Files*, click "PNFS Export List" to arrive at the *PNFS Exports Page*.

the 0 in the last line means no fsck checks at boot time. For example:

```
stkensrv1:/E872 /pnfs/E872 nfs user,intr,bg,hard,rw,noac 0 0
```

Usually, `local_mount_point` is the same as `enstore_server_directory`. Make sure that `local_mount_point` exists! (A typical error message is "backgrounding".)

6. Install UPS/UPD on your system. See Part III of the UPS/UPD manual at http://www.fnal.gov/docs/products/ups/ReferenceManual/parts.html#partIII.
7. Install the **encp** product on your machine (see below).

3.3 Installing Encp

This section pertains to you only if you access Enstore directly (not through dCache). To install the **encp** product from KITS using UPD, run:

```
$ setup upd

$ upd install -G "-c -q <xyz>" encp
```

where **<xyz>** stands for one of the Enstore systems. Currently, these include:

stken	for general Fermilab users
d0en	for D0 users
cdfen	for CDF users

For example, a CDF experimenter would type:

```
$ upd install -G "-c -q cdfen" encp
```

Chapter 4: PNFS Namespace

PNFS is a virtual file system package that implements the Enstore namespace. Refer to section 1.2 *PNFS Namespace* for introductory information on PNFS.

4.1 UNIX commands You can Use in PNFS Space

Data files do not actually reside in the `/pnfs` namespace. Errors occur on attempts to read or write the content of the files, or to manipulate the content. Therefore, UNIX commands such as **`cat`**, **`more`**, **`less`**, **`grep`**, **`head`**, **`tail`**, **`wc`**, **`od`**, **`file`**, **`cp`**, and so on, fail if you run them on files listed under `/pnfs`.

However, virtually any non-I/O UNIX command can be used in the `/pnfs` namespace. For help with these commands, consult a UNIX manual or the man pages. Read and write access is governed by standard UNIX file permissions. Commands that you may find useful include:

• ls[7]	• pwd
• mv and mvdir[8]	• find
• rm and rmdir	• cd
• mkdir	• ln (hard links only)[9]
• stat[10]	• chown
•	• chmod

The paths: /pnfs/xyz, /pnfs/fs/usr/xyz and /pnfs/fnal.gov/usr/xyz all refer to the same directory. When using Enstore without dCache the first path is most often used. When using dCache (with or without Enstore) the second path is

7 Commands that recersively walk directory trees like **`ls -r`**, **`ls -R`**, **`find`** and **`updatedb`** should not be run on a PNFS filesystem.

8 Files and directories must not be moved across PNFS database areas. Doing so will destroy Enstore metadata.

9 For ln, hard links must be used to ensure that all the metadata information is linked; symbolic links do not work properly.

10 Stat is not available in all operating

most often used. The third path type is used with SRM transfers.

4.2 PNFS Limitations

- PNFS uses NFS version 2. Newer systems are defaulting to NFS 4. To force the use of NFS 2, include `vers=2` mount option.
- On some SGI kernels (confirmed on 6.5.27 and 6.5.28) the NFS implementation is broken. Use the `proto=udp` mount option as a workaround.
- Recursive commands like **`ls -lR`** and **`find`** will put a lot of load on PNFS. Their use is strongly discouraged.
- When deleting a directory containing a large number of files do not do **`rm -[r]f *`**. Instead use a loop that will sleep after each file is removed. Doing this will take a lot of unnecessary stress off of PNFS.

4.2.1 PNFS Directory Limitations

- It is recommended to keep the number of files in any given PNFS directory under 2000. This is recommended for any NFS-based file system.
- The maximum length of a file in PNFS is 200 characters. However, **`encp`** will furthur restrict the filename length with respect to the size of the file.

4.3 About PNFS Tags

Before files can be written to tape, Enstore needs to know where and how to write them. Pnfs uses tag files (usually just called tags) in the `/pnfs` namespace to specify this type of configuration information, and **encp** transfers this information to Enstore. Tags are associated with directories in the `/pnfs` namespace, not with any specific file, and thus apply to all files within a given directory (with the exception noted below). When a new directory in the `/pnfs` namespace is created, it inherits references to the tags of its parent directory. It is a feature of PNFS that a change to a parent directory will also affect its existing subdirectorys' tag references.


Manually setting a directory's tags will destroy references to its parent directory's tags. This may be what you want to do, but be aware.
A file gets the tag references of its directory as they exist when the file is written to Enstore, and these are what **encp** uses to access it. Subsequent changes to a directory's tag references do not affect pre-existing files, therefore it's possible to have files in a directory to which the current directory tags do not apply.

Allowable characters within tags are: alphanumeric characters, underscore (_), dash (**-**), and slash (**/**).

4.3.1 Tag Listing

The tags include:

file_family	This tag determines the file family associated with all files in this directory. See section 2.2.1 *File Family* for information on file families.
file_family_width	This tag determines the file family width associated with all files in this directory. See section 2.2.2 *File Family Width* for information on file family width.
file_family_wrapper	This tag determines the file family wrapper associated with all files in this directory. See section 2.2.3 *File Family Wrapper* for information on file family wrappers. The default is `cpio_odc`.
Library	This tag determines the virtual library (and thus the library manager) associated with all files in this directory. See section 8.3 *Library Manager* for information about the library.
storage_group	This tag determines the storage group associated with all files in this directory, and shows up as your experiment's top level directory under `/pnfs`. Typically, one storage group is associated with an entire experiment. A storage group is assigned to each experiment by the Enstore administrators. Users never change this tag.

4.3.2 How to view Tags

Off-site users cannot mount pnfs, and therefore cannot see tags. On-site users: to see the values of the tags for a given directory, first setup **encp** (with qualifier, see section 6.1 *Setup encp*) then **`cd`** to the `/pnfs` subdirectory of interest (or enter the directory as an argument to `--tags`) and enter the command:

```
% enstore pnfs --tags
    .(tag)(file_family) = dcache
    .(tag)(file_family_width) = 1
    .(tag)(file_family_wrapper) = cpio_odc
    .(tag)(library) = eagle
    .(tag)(storage_group) = test
    -rw-rw-r--   11 xyz     sys            6 Jul 26 10:22 .(tag)(file_family)
    -rw-rw-r--   11 xyz     sys            1 May  5  2000 .(tag)(file_family_width)
    -rw-rw-r--   11 xyz     sys            8 May  5  2000 .(tag)(file_family_wrapper)
```

```
-rw-rw-r--   11 xyz     sys            5 May  5  2000 .(tag)(library)
-rw-r--r--   11 xyz     sys            4 Jul 26 10:20 .(tag)(storage_group)
```

The output first lists the tags and their values, then the tags again in long format to show the owners and protection modes.

Chapter 5: Copying Files with Encp

Encp is an end-user command used to copy data files from disk to storage media and vice-versa. Its use is being discouraged in favor of the dCache, however we document it here for completeness.
Encp is maintained in KITS and in AFS product space as a separate product from Enstore, and is designed to be used in conjunction with it. **Encp** does not support recursive copies of data to and from Enstore; ensync is provided as a wrapper to **encp** for that purpose when writing to Enstore, see section Chapter 7: *Copying Directory Structures with Ensync*. **Encp** can copy multiple files to a single directory only. **Encp** can be used only from on-site machines in the fnal.gov domain. For off-site use, see section Chapter 5: *Using the dCache to Copy Files to/from Enstore*.
In this chapter, we assume you have UPS/UPD running on your local machine.

5.1 Setup encp

To setup **encp**, run the command:
```
% setup -q <qualifier> encp
```
where **<qualifier>** stands for one of the Enstore system hosts. Currently, these include:
stken for general Fermilab (and CMS) users
d0en for D0 users
cdfen for CDF users
For example, a CDF experimenter would type:
```
$ setup -q cdfen encp
```
If you don't specify the qualifier, the environment variable ENSTORE_CONFIG_HOST may get set to the wrong value (described in section Error: Reference source not found). Check that ENSTORE_CONFIG_HOST specifies the correct server.
The ENSTORE_USER_DEFINED_CONFIG_HOST and ENSTORE_USER_DEFINED_CONFIG_PORT environmental variables can be specified before executing setup without the -q option. The setup will use these user defined values to set ENSTORE_CONFIG_HOST and ENSTORE_CONFIG_PORT.

5.2 Encp Command Syntax and Usage

Encp plays the same role in the Enstore system that **cp** plays in UNIX. The syntax is:
```
% encp [<options>] <source_file> <destination_file>
```

With the exception of the option **--help**, we defer the list and definitions of options to section Error: Reference source not found, and instead proceed with usage information.

Use the **--help** option to request the option listing for **encp** (we give the option listing in section Error: Reference source not found), or the **--usage** option for syntax information:

```
% encp --usage
encp [OPTIONS]... <source file> <destination file>
encp [OPTIONS]... <source file> [source file [...]]\
 <destination>
```

5.3 Copy Files to and from Enstore Media

5.3.1 Run encp

First, setup **encp** (using the **-q** flag). You can use filename expansion (wildcard characters to specify a group of files). We recommend, however, that you copy one file at a time. Run the command as follows to copy a file to Enstore:

```
% encp [<options>] /<path-to>/.../<localfilename> \

 /pnfs/<storage-group>/.../<targetdir>/<remotefilename>
```

The presence of **/pnfs/** in the destination path indicates that this is a copy to the Enstore system (see section 1.2 *PNFS Namespace*). To copy from Enstore, change the source and destination file specifications, e.g.,:

```
% encp [<options>] \

 /pnfs/<storage-group>/.../<targetdir>/<remotefilename> \

 /<path-to>/.../<localfilename>
```

5.3.2 Examples

1. Standard copy to Enstore; no options. Copy `myfile` to the directory `/pnfs/expt1/subdir/`:

```
% encp /path/to/myfile /pnfs/expt1/subdir/
```

2. Standard copy; no options. Download `/pnfs/expt1/subdir/myfile` to a different local directory from the cwd, and change the filename:

```
% encp /pnfs/expt1/subdir/myfile \
```

```
/other/local/dir/newfilename
```

3. Request the process to output some information to screen (**`--verbose`**). Again, copy `myfile` to the directory `/pnfs/expt1/subdir/`:

```
% encp --verbose 3 /path/to/myfile \ /pnfs/expt1/subdir/
```

4. Copy all the files in the cwd starting with the string `trigger1` to the directory `/pnfs/expt1/subdir/`:

```
% encp ./trigger1* /pnfs/expt1/subdir/
```

5. Copy all the files in `/pnfs/expt1/subdir/` starting with the string `trigger1` to the cwd:

```
% encp /pnfs/expt1/subdir/trigger1* .
```

5.4 Additional Diagnostic Executables

Packaged with **encp** are four executables. They are **ecrc**, **ddencp**, **en_check** and **`enmv`**. The first program calculates the CRC of a file located on disk. The second does a file to file copy using the same mechanism that **encp** uses. The third is a script that will tell you if the specified file is on tape.

5.4.1 ecrc

The ecrc program reads a file on disk and reports the adler32 CRC for the file. Usage:

```
ecrc [-0 | -1] [-d | -h | -H | -a] [-v] <file_name>
```

-0 Use enstore's 0 seeded adler32 CRC algorithm. (default)

-1 Use the standardized 1 seeded adler32 CRC algorithm. The actual adler32 algorithm says that the CRC value should be initialized to 1. Enstore uses 0 for this value; not 1.

-d Display the output in decimal form (default).

-h Display the output in lower case hexidecimal form.

-H Display the output in upper case hexidecimal form.

-a Display both the zero and one seeded CRCs in decimal and hexidecimal.

For example,

```
$ ecrc -v ~/test_files/10MB_002
size 10485760 buf_size 1048576 blocks 10 rest 0 CRC 1294565006
```

To see what CRC information Enstore knows, see section 9.4 *enstore pnfs*, in particular the `--xref` option of the `enstore pnfs` command.

5.4.2 ddencp

The program **ddencp** copies a local file to another local file. It uses the same mechanism that **encp** uses. Its uses include: measuring disk rates, checking for disk problems and determining which filesystems support different types of i/o.
Usage:

```
ddencp [-cevt] [-a <# of buffers>] [-b <buffer size>] \
 [-l <mmap buffer size>] [-dmSDR] <source_file> \
 [-dmSDR] <dest_file>
```

-c Remove the source file's contents from the filesystems buffer cache before performing the file transfer. This allows the user to always read from disk and get more accurate rates. This option does not work on all systems.

-e Performs a complete readback and CRC check of the destination file.

-v Print out verbose information.

-t Use the multithreaded implementation.

-d Use direct i/o instead of POSIX i/o. This type of i/o bypasses the filesystem's buffer cache.

-m Use memmory mapped i/o instead of POSIX i/o. If -t is also specified the -t switch is ignored.

-S Use the O_SYNC option when opening the file.

-D Use the O_DSYNC option when opening the file.

-R Use the O_RSYNC option when opening the file

-A Use advisory locks when accessing the file.

-M Use mandatory locks when accessing the file.

-a When used with -t, this option specifies the number of buffers that are used for

the transfer. (default 3)

-b This specifies the size of the transfer buffer. When used with the -t option, this is the size of each of the buffers. (default 256K)

-l When using memmory mapped i/o, -m, this is the size of each segment of file that is mapped at one time. (default 256K)

The position of the -d, -m, -S, -D and -R switches does effect the behavior. If the switch appears before the source_file, then it is active for just the source file. If it appears after the source file, but before the destination file then it only effects the destination file. To use the same switch for both the source and destination it must be specifed twice, once for each file.
To read a source file with mandatory locks, the set-gid-bit needs to be set with the group execute bit turned off. On Linux, to use mandatory locks the file system needs to be mounted with the "mand" option enabled.

5.4.3 en_check

This command determines if a file is on tape.
Usage:

```
en_check <pnfs_path>
```

Results (exit statuses):

0 file is on tape

1 file is not on tape

2 it was unable to determine (at this time) if it is on tape or is not on tape (Reasons for exit status 2 include but are not limited to: Enstore is down for maintenance, or the tape on which the file is believed to exist is in NOACCESS or NOTALLOWED state.)

With the use of dCache, obtaining a non-success exit status is expected until dCache writes the file into Enstore.

5.4.4 enmv

This is an Enstore and PNFS aware mv like utility. It moves one file at a time. It does not move directories.
Usage:

```
enmv [-h | --help | --usage] [--verbose <level>] <source file> \
  <destination file>
```

enmv is necessary for moving files between directories in different PNFS databases. Using **mv** to move a file accross PNFS databases will result in lost metadata.

5.5 More about Encp

5.5.1 Preventing Unwanted Overwriting

When an **encp** job starts, it first creates a zero length output file for every input file. In this way it reserves the necessary filenames and thus prevents another party from starting a competing **encp** process which would clobber the first.

5.5.2 Killing an encp Process

There are four traditional ways to abort a process:

- Ctrl-C (SIGINT)
- Ctrl-\ (SIGQUIT)
- kill (SIGTERM)
- kill -9 (SIGKILL)

The first three result in **encp** removing any remaining zero length files (as discussed directly above). With a "kill -9", no cleanup occurs. For multi-file transfers, files successfully transferred before the signal is caught will be left alone.

5.5.3 Encp Transfer Rates Defined

You can find out the network rates by running the command **encp --verbose 1** or from the **Encp History** page (see section 10.10 *Encp History*).

Network transfer rate	The rate at which the file was transferred over the network between the **encp** node and the mover node, in megabytes per second.
Transfer rate	The rate measured when moving the file between the disk local to **encp** and the tape, in megabytes per second (includes reading file, network transfer of file and writing file; does not include tape mount or seek times).
Drive rate	The rate measured when reading/writing from/to the tape drive, in megabytes per second.

Disk rate — The rate of reading/writing the file from/to the disk local to **encp**, in megabytes per second.

Overall rate — The rate for the overall process (from when the mover connects to **encp** until the mover sends its final "success or failure" message to **encp**), including all **encp** and media overhead, in megabytes per second (this does not include time spent in the library manager queue).

Without the --threaded switch the network and disk rates will be reported as the same.

5.5.4 Isolating Source of Bottlenecks

Encp (as of v3_1) supports isolating the rate transfers in the tape, disk and network via the option **`--threaded`** used in conjunction with the option **`--verbose`** with a value of 1 or higher. If **`--threaded`** is not specified, then the network and disk rates are calculated the same way as before, and display the same value as one another. The various rates are defined in the online monitoring pages, under **Encp** History Help. See, for example, `http://www-stken.fnal.gov/enstore/encpHelp.html`. Here is an example without **`--threaded`** (with off-topic output removed for brevity):

```
% encp --verbose 1 /pnfs/xyz/10MB_002 /tmp/myfile
```

with output:

```
...
Transfer /pnfs/xyz/10MB_002 -> /tmp/myfile: 10485760 bytes copied from 'TEST01' at 1.57  MB/S
(1.67 MB/S network) (2.87 MB/S drive) (1.67 MB/S disk)
...
Completed transferring 10485760 bytes in 1 files in 14.2875500917 sec.
Overall rate = 0.7 MB/sec. Drive rate = 2.87 MB/sec.
Network rate = 1.67 MB/sec. Exit status = 0.
```

Note in the above output, the network and disk rates are the same.
Here is an example with **`--threaded`** and **`verbose 1`** (abbreviated output); note that the rates are separated, so that you can see where the bottleneck is (the disk, in this case):

```
% encp --verbose 1 --threaded /pnfs/xyz/10MB_002 /tmp/myfile
```

It produces output:

```
...
Transfer /pnfs/xyz/10MB_002 -> /tmp/myfile:
10485760 bytes copied from 'TEST01' at 2.41  MB/S
(8.09 MB/S network) (9.36 MB/S drive) (2.71 MB/S disk)
...
Completed transferring 10485760 bytes in 1 files in 14.9129179716 sec.
Overall rate = 0.671 MB/sec. Drive rate = 9.36 MB/sec.
Network rate = 8.09 MB/sec. Exit status = 0.
```

The network and drive each have rates above 8 MB/s, and the disk rate is only 2.71 MB/s.

5.5.5 Encp Error Handling

Encp has functionality to retry and resubmit requests, where we distinguish between these two terms. **Encp** will *retry* (i.e., resend) a request after an error occurs. **Encp** will *resubmit* a request if it has been waiting for a mover for over 15 minutes; this is not due to an error condition but rather to keep queues current regardless of the server condition. The **encp** exit statuses are zero (0) for success, one (1) for error.

There are two general classifications of errors in **encp**: those that can be retried and those that can't. Three "retriable" errors can occur before the error "TOO_MANY_RETRIES" occurs.

The most common nonretriable errors include:

NOACCESS — the system has marked the volume as "potentially" bad

NOTALLOWED — an enstore administrator has marked a tape as unavailable for user access

USERERROR — usually is a file accessibility problem (doesn't exist, has wrong permissions, etc.)

Among the less common ones, there are:

VERSION_MISMATCH — the **encp** version is no longer compatible with the running Enstore system

CRC_MISMATCH — indicates a corruption error

FILE_WAS_MODIFIED — **encp** determined that another process modified the file during the transfer

Ask your Enstore administrator if you see others.

5.5.6 Finding files in different Enstore Systems

File reads: When reading from Enstore, **encp** can determine whether the current value of $ENSTORE_CONFIG_HOST (see section Error: Reference source not found) is pointing to the Enstore system that contains the requested file. If it points to the wrong one, **encp** will try the other Enstore installations to find the requested file. If the file is found, **encp** will retrieve the file; if the file is not found on any Enstore system, an error is returned to the user.

File writes: When writing to Enstore; the value of

$ENSTORE_CONFIG_HOST is always used.

5.5.7 Order of Processing Queued Requests

For reads, files are sorted out by volume. When all files from a single volume are complete, the next volume's files are requested.
For writes, one file at a time is submitted to the library manager. The order is that in which the files are specified on the command line. The tape is kept mounted during file writes on a best-effort basis. See Chapter 11: *Job Priority and Queue Management* for more information.

5.5.8 NULL File Directories

When **encp** accesses files via a null mover, a directory in the filepath must contain the name NULL, e.g., `/pnfs/expt1/NULL/myfile`.

5.5.9 Important Environment Variables

There are two important environment variables that are generally set in the Enstore setup script. Users who work on more than one Enstore system (e.g., stken and cdfen) at a time in different windows may need to know about these in case they use the wrong window for a particular Enstore system!
The variables are:

$ENSTORE_CONFIG_HOST

points to the Enstore server that is running the configuration server (see section 8.6 *Configuration Server*).

All production systems currently use srv2 (i.e., cdfensrv2, d0ensrv2 or stkensrv2) as the $ENSTORE_CONFIG_HOST computer. This is different from the computer from which the pnfs filesystem is mounted (which is srv1, i.e., cdfensrv1, d0ensrv1, stkensrv1).

$ENSTORE_CONFIG_PORT

sets the port number; the value is (by convention) 7500 for all installations at Fermilab.

$ENSTORE_RANDOM_UB

$ENSTORE_RANDOM_LB

When reading from `/dev/zero`, `/dev/random` or `/dev/urandom` these represent the upper and lower bounds the

random amount of data to read in bytes.

$ENCP_CANONICAL_DOMAINNAME

When reading files; **encp** attempts to resolve the given name with names like **`/pnfs/xyz`**, **`/pnfs/fs/usr/xyz`** and **`/pnfs/<network_name>/usr/xyz`**. If the hostname name of the current host resolves, for example to pool.storage.fnal.gov, then **encp** would look for **`/pnfs/storage.fnal.gov/usr/xyz`**. If the real path is **`/pnfs/fnal.gov/usr/xyz`**, then we need to set ENCP_CANONICAL_DOMAINNAME to fnal.gov for **encp** to automatically try the correct canonical PNFS path.

5.5.10 Encp Limitations

Encp does not work from behind a firewall. It uses an "active" protcol for data transmition.
New versions of Linux come with an internal firewall enabled by default. To use **encp** on these nodes the firewall must be disabled first.

5.6 Encp Command Options

In this section, we have placed a bomb in front of any option that should be used with utmost care; these options, if misused, can adversely affect not only your jobs, but those of others, as well. We have placed a pointing finger in front of options that, if misused, may adversely affect your own job, but not others' jobs.


--age-time <AGE_TIME> Specifies the time period, in minutes, after which the priority is eligible to change from the current job priority. We recommend that you do not set this, just use the default (which is "never").


--array-size <ARRAY_SIZE) Sets the number of buffers in the array. If --threaded is specified but this option is not, array-size defaults to 3. If this is used without --threaded, this value becomes 1 and is ignored. Changing this value for multi-threaded transfers may increase transfer speed.


--buffer-size <BUFFER_SIZE>

Sets the number of bytes of data to transfer at one time (default is 256k). Increasing this value may increase transfer speed. This value must remain lower than the available memory.


--bypass-filesystem-max-filesize-check

Disables the check to protect against the user reading from Enstore a file larger than the maximum size file the local filesystem supports. Use this switch with care.

--check — Checks that enstore is running, that the metadata is ok, and that **encp** would thus start. Running the **encp** command successfully using this switch is not sufficient to guarantee that a transfer would succeed.

Result of 0 is success, 1 is failure, 2 means indeterminable at this time.

--copies <COPIES> — Directs **encp** to write <COPIES> number of additional multiple copies on tape. A value of zero is the default; indicating that only the original should be written.

It is possible to enable this feature by setting the library tag to contain a comma separated list of libraries without any white space.

--copy <COPY> — Directs **encp** to read the <COPY> number multiple copy on tape. A value of zero is the default; indicating that the original should be read.

--data-access-layer — Turns on special status printing; output has standardized format whether error occurred or not.


--delayed-dismout <DELAY> Specifies time period in minutes to delay dismount of volume. Use this to tell Enstore: “More work is coming for the volume, don’t dismount the volume too quickly once the current transfer is completed.”

 --delpri <DELPRI>

Changes the initial job priority by specified value after a period given by the age-time switch. We recommend that you don't set this, just use the default (1).

 --direct-io

Uses direct I/O for disk access on supporting file systems[11]. Generally, direct I/O makes disk access slower. But when the size of the read/write buffer is made large enough, say, 64Mb or larger, direct I/O is faster because of the skipped memory-to-memory copy.

--ecrc

(stands for Enstore crc) This can be used when reading from Enstore. After a file is written to disk, this causes Enstore to reread the disk copy of the file and recalculate the checksum on it.

 --ephemeral[12]

This option creates a temporary file family of name "ephemeral", and copies files to this ephemeral file family on storage media in the order specified. Overrides file family tag in /pnfs destination directory.

 --file-family <FILE_FAMILY>

This is used to write data on volumes assigned to specified file family. Overrides file family tag in /pnfs destination directory. (Footnote for --ephemeral applies here, too.)

--help

Displays the list of options for **encp**.

 --mmap-io

Uses memory-mapped I/O for disk access on supporting file systems (see the *Enstore Glossary* for an explanation). Make sure you have read and write permissions on the file.

11 Direct I/O is not universally supported; some filesystems, versions of filesystems, kernels, etc. do not support it. If this doesn't work for you, contact an enstore admin, and communicate your kernel, library versions, filesystem and filesystem version.

12 The options --ephemeral and --file-family require care when used so that tapes do not get mounted in a way that causes improper and/or inefficient tape usage. Beware of runaway scripts!


--mmap-size <MMAP_SIZE> The amount of data to map from the file to local memory at one time in bytes (default is 96Mb); use with --mmap-io.

--no-crc — Tells **encp** to bypass the crc[13] on the local file. (For the minor performance enhancement that this affords, we discourage use of this option.)

--pnfs-is-automounted — Typically, users should not automount pnfs. If you do, you can specify this option. It alerts **encp** to retry errors due to known OS automounting problems.

Do not use this in non-automounted cases; it can slow the setup of the transfer.


--priority <PRIORITY> Sets the initial job priority to the specified integer value. We recommend that you don't set this, just use the default.

--threaded — Multithreads the actual data transfer.

--usage — Displays information about the **encp** options.

--verbose <LEVEL> — Changes the amount of information printed about the transfer; provide an integer value. Default is 0. Larger integer numbers provide more "verbosity". Largest meaningful number may change as development continues.

--version — Displays **encp** version information.


If you feel compelled to set `--priority`, `--delpri` or `--age-time`, please email *enstore-admin@fnal.gov* first with an explanation, as the defaults should work in almost all cases and changing them may affect other users. Priority goes in strict number sequence, where a higher number means higher priority. Note that Enstore's selection of which file to transfer at a given time uses a much more complicated algorithm than simple priority, however. See Chapter 11: *Job Priority and Queue Management*.

13 CRC stands for Cyclic Redundancy Check, a type of checksum.

Chapter 6: Copying Directory Structures with Ensync

6.1 About Ensync

Ensync is a wrapper for **encp** that allows you to copy the contents of an entire directory structure to Enstore via a single command. It is intended for uploading files to Enstore only, not downloading from it. Ensync makes a call to **encp** to handle each file transfer, and the transfers are done serially. The ensync program is intended for smaller experiments lacking the resources to create their own scripts to do this sort of thing, and without the high data volume of the large experiments.

Ensync works similarly to **`rsync -R`** in that it recursively copies files down a directory hierarchy, which **`encp`** cannot do. It behaves in much the same way that **`rcp`** does, but has more features and uses the rsync remote-update protocol to greatly speed up file transfers when the destination file already exists. It creates an area in PNFS namespace structurally similar to that from which the user is copying. It copies files/directories from a user's local disk to this space. If a file already exists in Enstore with the same relative path/filename as one on the user's disk, the user's file does not get copied; the preexisting Enstore file stays as is.

6.2 Ensync Command Syntax

The command takes two arguments, the "from" and the "to" directories or files. The syntax is:

```
% ensync /<path_to>/.../<local_dir> /pnfs/.../<dest_dir>
```

There are no options to specify. A few notes:

- Symbolic links work if the target is under the same mount point as the link.
- Hard links are not kept. A new copy for each link would get two separate, identical files.
- Ensync tranfers one file at a time, it does not transfer them in parallel.

Chapter 7: Overview of the Enstore Servers

In this chapter we describe the software modules that act as Enstore servers and the libraries with which they interact. The servers include:

- File Clerk (FC)
- Volume Clerk (VC)
- Library Manager (LM)
- Mover (MV)
- Media Changer (MC)
- Configuration Server (CS)

All of the above-listed servers must be running in order for data reads and writes to succeed.
The Enstore monitoring framework includes:

- Inquisitor
- Alarm Server (AS)
- Log Server (LS)
- Event Relay (ER)
- Monitor Server
- Accounting Server
- Drivestat Server
- Information Server
- Ratekeeper

Typically, data transfer can still take place even if any of these monitoring systems is down.

7.1 File Clerk

The File Clerk (FC) is a server that tracks files in the system. It manages a database of metadata for each data file in the Enstore system. The metadata includes the file's name, its unique identifier (the bit file ID, or bfid, that the FC itself assigns to each new file), the volume on which it resides, and so on.

You can get information on specific files using the **`enstore info`** command; see section 9.1 *enstore info*.

7.2 Volume Clerk

The Volume Clerk (VC) is a server that stores and administers storage volume (tape) information. You can get information on specific volumes using the **`enstore info`** command; see section 9.1 *enstore info*.

7.3 Library Manager

A Library in Enstore is comprised of both the physical media and a robot arm used to mount the media in attached drives. An Enstore library is typically called a robot. A library/robot interfaces to software that controls the robot arm (the Media Changer, see section Error: Reference source not found). Each library can contain a variety of media types and employ different types of media drives.

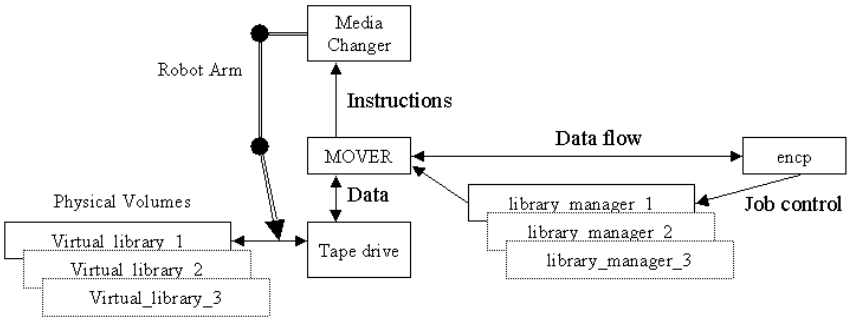
A Virtual Library (VL) is a subset of an Enstore library. It can contain one and only one type of media. A Library Manager (LM) is a server which is bound to a single Virtual Library (VL), and controls what happens within that VL. We speak of bound "LM-VL pairs". An LM receives requests for file reads and writes from the user, stores these unassigned requests in a queue, prioritizes them, and dispatches the requests to a Mover for actual data transfer to and from its VL.

There may be many LM-VL pairs in an Enstore system. There may be more than one LM-VL pair for each media type, but not vice-versa. For example, given an STK Powderhorn library holding 20, 60 and 200 GB media, Enstore would need to divide it into at least three LM-VL pairs.

You can get information on specific library managers using the **`enstore library`** command; see section 9.2 *enstore library*.

7.4 Mover

A Mover (MV) is a process responsible for efficient data transfer between the **encp** process and a single, assigned media drive in a library (robot). The Mover receives instructions from a Library Manager (LM) on how to satisfy the users' requests. The Mover sends instructions to the Media Changer (MC) (described in section 9.5) that services the Mover's assigned drive in order to get the proper volume mounted.



A mover can be configured to serve multiple LMs[14]. Allowing flexible LM assignment has two benefits:

- First, since a virtual library (an LM-VL pair) handles only one type of media, a drive which can handle multiple types of media (e.g., different capacity media) can be shared by multiple LM-VL pairs without a static partitioning of the system.
- Secondly, suppose user groups A and B want to share the capacity of a VL, in which half the tapes belong to group A and the other half to group B. You want to guarantee that groups A and B each get one third of the tape drives, and that the last third is shared. To do this, your administrator can configure the Movers to partition resources in the VL, and assign an LM to each type of use.

7.5 Media Changer

The Media Changer (MC) mounts and dismounts the media into and out of drives according to requests from the Movers. One MC can serve multiple drives and thus multiple VLs (the image in section Error: Reference source not found shows an MC associated with only one drive). When the drives are in the robot, the MC is the interface to the robotic software.

7.6 Configuration Server

The Configuration Server (CS) maintains and distributes the information about Enstore system configuration, such as the location and parameters of each Enstore component and/or server. At startup, each server asks the CS for the information it needs (e.g., the location of any other server with which it must communicate). New configurations can be loaded into the CS without disturbing the current running system.

14 The media types governed by the LMs must be supported by the Mover's assigned drive.

7.7 Inquisitor

The Inquisitor monitors the Enstore servers, obtains information from them, and creates reports at regular intervals that can be viewed on the web under `http://hppc.fnal.gov/enstore/`. See section Error: Reference source not found for an illustration of an Inquisitor task. The reports created by the Inquisitor include **Enstore Server Status** (section 10.4), **Encp History** (section 10.10), **Enstore Configuration** (section 10.11), and **Enstore Log Files** (section 10.13).

 If the Inquisitor goes down, the **System-At-A-Glance** web page (described in section 10.3) indicates this by a red ball next to *Inquisitor*. In this case, data can still be transferred via **encp**, however, the information on the reports mentioned above doesn't continue to update!

7.8 Alarm Server

The Alarm Server (AS) maintains a record of alarms raised by other servers, and creates a report available online and described in section 10.12 *Enstore Active Alarms*. Since Enstore attempts error recovery whenever possible, it is expected that raised alarms will need human intervention to correct the problem. The AS compares each newly raised alarm with the previously raised ones (it raises a counter) in order to prevent raising the same alarm more than once. Alarm output can be configured to be sent in email messages, to a web page, and so on for notification.

7.9 Log Server

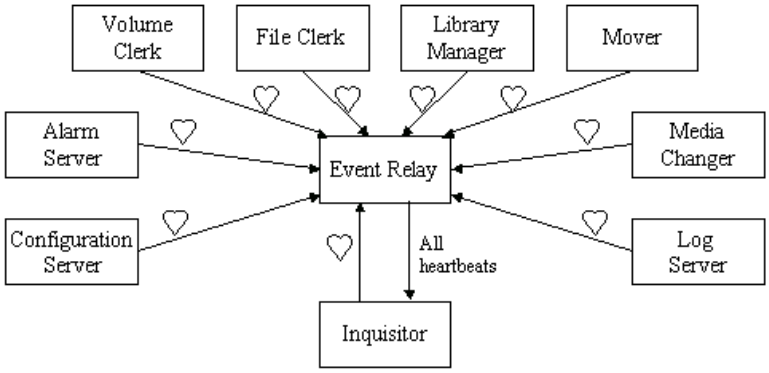
The Log Server (LS) receives messages from other processes and logs them into formatted log files available online and described in section 10.13 *Enstore Log Files*. These messages are transactional records. Log files are labeled by date. Every night at midnight, the currently opened log file gets closed and another one is opened. Logs are backed up to tape.

7.10 Event Relay

The Event Relay (ER) is a server that forwards messages based on subscription. All the Enstore servers send messages to the ER. Any server may "subscribe" to the ER in order to have messages of particular types forwarded to it.

For example, the ER periodically receives "I'm alive" messages (called *heartbeats*) from the other servers in the system. The Inquisitor (section Error: Reference source not found) subscribes to the heartbeat messages, so

the ER forwards these messages to it. This is illustrated in the image below:



☞ If the ER goes down (indicated by a red ball next to *Event Relay* on the **System-At-A-Glance** web page described in section 10.3), the information on **Enstore Server Status** (see section 10.4) and the other web pages described in Chapter 10: *Monitoring Enstore on the Web* may not be accurate.

7.11 Monitor Server

The Monitor Server (MS) is available for investigating network-related problems. It attempts to mimic the communication between **encp**, the corresponding library manager, and the mover. To initiate a test of this kind, you must use the `enstore monitor` command, see section 9.3 *enstore monitor*.

7.12 Accounting Server

The accounting server is a front-end to a Postgres SQL database, and at this time is not intended for use by end users. It maintains statistical information on a running system. Such information is not essential to operations, however it can be used by administrators to analyze the performance and utilization of the system for purposes of troubleshooting and future planning.

7.13 Drivestat Server

Drivestat server maintains statistical information of the drives. This is used to update the “ingest rate” plots. As with the accounting server, such information is not essential to operations, however it can be used to analyze the performance and utilization of the system for purposes of troubleshooting and future planning.

7.14 Info Server

The Information Server is a read-only server that maintains detailed file and volume information. You can access this information for particular files and volumes using the **`enstore info`** command and its various options (see section 9.1 *enstore info*).

7.15 Ratekeeper

The ratekeeper performs a number of monitoring tasks that update the accounting DB at regular intervals with information about instantaneous rate, drives busy and slot usage information.

Chapter 8: Enstore Commands

Enstore provides commands that allow you to communicate with various components of the system. The basic syntax of all Enstore commands is

```
% enstore <command> [--option [argument] ...]
```

All options start with a double dash (**--**). The return codes are 0 (zero) for success, non-zero for failure (currently all failures return number 1).

8.1 enstore info

As of encp v3_2, the command **enstore info** supersedes **enstore file** and **enstore volume**. The developers may decide to remove these latter two commands in future versions of **encp**.

This command communicates with the File Clerk (see section 8.1 *File Clerk*) and the Volume Clerk (see section 8.2 *Volume Clerk*). It returns information about specified file(s) or volume(s).

Syntax:

```
% enstore info [--option [argument] ... ]
```

Options:

-h, --help

Prints the options (i.e., prints this message). Example:

```
$ enstore info --help
```

```
Usage:
       info [ -h --bfid= --help --list= --ls-active= --usage ]
       --bfid <BFID>         get info of a file
       --file <PATH|PNFSID|BFID|VOL:LOC>  get info on a file
       --find-all-copies <BFID>  find all copies of this file
       --find-copies <BFID>  find the immediate copies of this file
         --find-duplicates <BFID>  find all duplicates related to
this file
        --find-original <BFID>  find the immediate original of this
file
       --find-the-original <BFID>  find the very first original of
this file
       --gvol <VOLUME_NAME>  get info of a volume in human readable
time
                             format
   -h, --help                print this message
       --just <VOLUME_NAME>  used with --pvols to list problem
       --list <VOLUME_NAME>  list the files in a volume
       --ls-active <VOLUME_NAME>  list active files in a volume
       --ls-sg-count         list all sg counts
       --pvols               list all problem volumes
```

```
--show-bad            list all bad files
--show-copies <BFID>  all copies of a file
--show-file <BFID>    show info of a file
--usage               print short help message
--vol <VOLUME_NAME>   get info of a volume
--vols                list all volumes
```

--bfid <BFID>
Returns information (metadata) about the file corresponding to the specified bfid.
You can get the bfid of a file from the **`enstore pnfs --bfid <FILE_NAME>`** command (section Error: Reference source not found); get the filename from searching PNFS namespace.
Example:

```
$ enstore info --bfid CDMS105770745000000
{'bfid': 'CDMS105770745000000',
 'complete_crc': 1191066979L,
 'deleted': 'no',
 'drive': 'stkenmvr7a:/dev/rmt/tps0d1n:4560000022',
 'external_label': 'VO3222',
 'location_cookie': '0000_000000000_0005661',
 'pnfs_mapname': '',
                                                    'pnfs_name0':
'/pnfs/fs/usr/test/xyz/srmtest/ar017983.0001phys_10',
 'pnfsid': '000500000000000000190EA8',
 'pnfsvid': '',
 'sanity_cookie': (65536L, 3203712884L),
 'size': 197354833L}
```

--find-all-copies <BFID>
Report all the file BFIDs that are duplicates or multiple copies of the specified file BFID, including the specified file itself.
Multiple copies are extra copies of a file written by the same encp process that wrote the original file. Duplicated copies are

multiple copies that were written to another tape by the Enstore administrators some time after the original was written to tape.

Here are two files where the first BFID shone is the original and the second one is a duplicate of the first.

```
$ enstore info --find-all-copies
  CDMS115788240600000

    CDMS115788240600000
    CDMS123800281300002

$ enstore info --find-all-copies
  CDMS123800281300002

    CDMS123800281300002
```

See also **encp--copies**; **enstore info --find-copies**, **--find-duplicates**, **--find-original**, --**find-the-original** and **--show-copies** for more information.

--find-copies <BFID>
Report the file BFIDs that are immediate duplicates or multiple copies of the specified file BFID, including the specified file itself. Multiple copies are extra copies of a file written by the same encp process that wrote the original file. Duplicated copies are multiple copies that were written to another tape by the Enstore administrators some time after the original was written to tape.

Here are two files where the first BFID shone is the original and the second one is a duplicate of the first.

```
$ enstore info --find-copies CDMS115788240600000

    CDMS123800281300002

$ enstore info --find-copies CDMS123800281300002
```

See also **encp--copies**; **enstore info --find-all-copies**, **--find-duplicates**, **--find-original**, --**find-the-original** and **--show-copies** for more information.

--find-duplicates <BFID>
Report the file BFIDs that are associated as a duplicate or multiple copy file of the specified file BFID, including the specified file itself. This command has the same effect as:

$ enstore info --find-all-copies `enstore info --find-the-original <BFID>` Multiple copies are extra copies of a file written by the same encp process that wrote the original file. Duplicated copies are multiple copies that were written to another tape by the Enstore administrators some time after the original was written to tape.

Here are two files where the first BFID shone is the original and the second one is a duplicate of the first.

```
$ enstore info --find-duplicates
  CDMS115788240600000

    CDMS115788240600000
    CDMS123800281300002

$ enstore info --find-duplicates
  CDMS123800281300002

    CDMS115788240600000
    CDMS123800281300002
```

See also **encp--copies**; **enstore info --find-all-copies**, **--find-copies**, **--find-original**, --**find-the-original** and **--show-copies** for more information.

--find-original <BFID>
Report the file BFIDs that is the immediate original of the specified duplicate or multiple copy file BFID. Multiple copies are extra copies of a file written by the same encp process that wrote the original file. Duplicated copies are multiple copies that were written to another tape by the Enstore administrators some time after the original was written to tape.

Here are two files where the first BFID shone is the original and the second one is a duplicate of the first.

```
$ enstore info --find-original
  CDMS115788240600000

    None

$ enstore info --find-original
  CDMS123800281300002

    CDMS115788240600000
```

See also **encp--copies**; **enstore info --find-all-copies**, **--find-copies**, **--find-duplicates**, --**find-the-original** and

--show-copies for more information.

--find-the-original <BFID>
Report the file BFIDs that is the overall original of the specified duplicate or multiple copy file BFID. Multiple copies are extra copies of a file written by the same encp process that wrote the original file. Duplicated copies are multiple copies that were written to another tape by the Enstore administrators some time after the original was written to tape.

Here are two files where the first BFID shone is the original and the second one is a duplicate of the first.

```
$ enstore info --find-the-original
  CDMS115788240600000

    CDMS115788240600000

$ enstore info --find-the-original
  CDMS123800281300002

    CDMS115788240600000
```

See also **encp--copies**; **enstore info --find-all-copies**, **--find-copies**, **--find-duplicates**, --**find-original** and**--show-copies** for more information.

This option may be used in any of four ways to return the same information, depending on what information you initially know about the file.
--file <PATH>
--file <BFID> (equivalent to **`enstore info --bfid <BFID>`**)
--file <PNFSID>
--file <VOLUME:LOCATION>
Returns information on the specified file.
This example uses the path:

```
$ enstore info --file /pnfs/test/NULL/1KB_251
```

```
{'bfid': 'WAMS111453908000000',
 'complete_crc': 0L,
 'deleted': 'no',
 'drive': 'rain:/dev/null:0',
 'external_label': 'NULL01',
 'gid': 6209,
 'location_cookie': '0000_000000000_0000609',
 'pnfs_name0': '/pnfs/test/NULL/1KB_251',
 'pnfsid': '000100000000000000056258',
 'sanity_cookie': (1024L, 0L),
 'size': 1024L,
 'uid': 5744}
```

The file could also be specified as one of the following (BFID, PNFSID or VOLUME:LOCATION (external_label:location_cookie):

```
$ enstore info --file WAMS111453908000000

$ enstore info --file 000100000000000000056258

$ enstore info --file
  NULL01:0000_000000000_0000609
```

--gvol <VOLUME_NAME>

This is just like **`enstore info --vol <VOLUME_NAME>`**, except that this one prints human-readable time fields (e.g., “declared”, “first_access” and “last_access” fields). Example:

```
$ enstore info --gvol VO3332
```

```
{'blocksize': 131072,
 'capacity_bytes': 64424509440L,
 'declared': 'Wed Jan 16 16:13:57 2002',
 'eod_cookie': '0000_000000000_0000044',
 'external_label': 'VO3332',
 'first_access': 'Fri May 10 12:59:35 2002',
 'last_access': 'Mon Oct 27 22:35:45 2003',
 'library': '9940',
 'media_type': '9940',
 'non_del_files': 43,
 'remaining_bytes': 1785262080L,
 'sum_mounts': 234,
 'sum_rd_access': 213,
 'sum_rd_err': 0,
 'sum_wr_access': 43,
 'sum_wr_err': 0,
 'system_inhibit': ['none', 'full'],
 'user_inhibit': ['none', 'none'],
 'volume_family': 'cms.objy_data_files.cpio_odc',
 'wrapper': 'cpio_odc'}
```

--just

Used with **`--pvols`** to list problem. See **`enstore info --pvols`**.

--list <VOLUME_NAME>
Lists the files in the specified volume with their volume name, bfid, size, location (file number) on volume, delete flag, and the original filename in pnfs.
You can get the volume name from the **enstore pnfs** command, using either **--xref** or **--layer** (section Error: Reference source not found), or from the "external_label" field of the **enstore info --bfid <BFID>** command (shown above).
This replaces both **enstore file --list <VOLUME_NAME>** and **enstore volume --list <VOLUME_NAME>**.
Example:

```
$ enstore info --list VO3222
    label  bfid               size   location_cookie        delflag
    original_name

    VO3222 CDMS106503213600000 983803 0000_000000000_0011536 deleted
    /pnfs/fs/usr/eagle/dcache-tests/274.dcache_page_p_27750
```

(This shows one of many lines appearing in the real output, and is reformatted to two lines for readability.)

--ls-active <VOLUME_NAME>
Lists active files in a volume.
You can get the volume name from the **enstore pnfs** command, using either **--xref** or **--layer** (section Error: Reference source not found), or from the "external_label" field of the **enstore info --bfid <BFID>** command (shown above).
Example:

```
$ enstore info --ls-active VO3222
    /pnfs/fs/usr/eagle/dcache-tests/101.dcache_page_a_24401
    /pnfs/fs/usr/eagle/dcache-tests/101.dcache_page_24401
    /pnfs/fs/usr/test/stress-test/myfile1
    /pnfs/fs/usr/test/stress-test/myfile3
    /pnfs/fs/usr/test/stress-test/file128m-11
    ...
```

--ls-sg-count <VOLUME_NAME>
Lists allocated tape counts by library and by storage group. If "storage group" has value "none", the negative number under "allocated" gives the number of tapes that are available in the robot, but not yet assigned to a storage group.
Example:

```
$ enstore info --ls-sg-count VO3332
```

```
     library    storage group  allocated
=======================================
       ...
       9940             ktev        189
       9940             lqcd        150
       9940        miniboone        132
       9940            minos        109
       9940             none        -13
       9940          patriot         20
       9940             sdss        608
       9940             test         28
       9940           theory         70
   CD-9940B              cms        129
       ...
```

--pvols [--just <VOLUME_1> <VOLUME_2> ...]
Without **`--just`**, this lists all problem volumes. With **`--just`** followed by a space-separated list of volume names, it lists only the problem volumes among the given list.
The columns returned are: volume name, primary status, primary status time, secondary status, secondary status time. (The time fields are relatively new; not all volumes will display them.)
Example:

```
$ enstore info --pvols
```

```
==== readonly
LEGL10             none         *     readonly 0913-1540
LEGL98             none         *     readonly 0819-2329
...
==== full
...
VO4845             none         *         full         *
VO4846             none 1023-1032         full         *
VO4847             none         *         full         *
VO4848             none         *         full         *
VO4849             none         *         full         *
VO4850             none         *         full 1016-2315
VO4851             none         *         full 1017-0409
...
$ enstore volume --pvols --just VO3332
```

```
(no sample output available)
```

--show-bad
Lists all files that are currently unavailable due to media problems. When a tape problem is discovered, the tape is sent to the vendor for file recovery. In the interim, a cloned tape is made available to users, with the bad files marked. This command option lets you list the bad files. The output lists the tape number, BFID, file size in bites, and pnfs path of file.
Example:

```
$ enstore info --show-bad

...
VO0053 CDMS105770745000000 95530315
 /pnfs/fs/usr/xyz/my_data/2004-4/.bad.F000xyz43_0000.mdaq.root
...
```

We show only one output line, and it is displayed on two lines for readability. Notice the "`.bad.`" at the front of the filename; this is how the bad files are marked.

--show-copies <BFID>
Report the file BFIDs that are associated as a duplicate or multiple copy file of the specified file BFID, including the specified file itself. This command has a similar effect to:
$ enstore info --find-duplicates <BFID>
but outputs more information. Multiple copies are extra copies of a file written by the same encp process that wrote the original file. Duplicated copies are multiple copies that were written to another tape by the Enstore administrators some time after the original was written to tape.

Here are two files where the first BFID shone is the original and the second one is a duplicate of the first. The columns are the BFID, Storage Group, Library, Media Type, Label, Deleted Status, Size, CRC, PNFS ID and Original PNFS Path.

```
$ enstore info --show-copies CDMS115788240600000

  CDMS115788240600000       ENDEV        LTO3        LTO3     TEST85
0000_000000000_0000001            no      5290065920      3951343656
000200000000000003DD20
/pnfs/data2/sl8500/fcdfcaf566/fcdfcaf566_4000_1157882036.data
  CDMS123800281300002       ENDEV        LTO3        LTO3     TEST21
0000_000000000_0000001            no      5290065920      3951343656
000200000000000004C4D8
/pnfs/data2/sl8500/fcdfcaf566/fcdfcaf566_4000_1157882036.data

$ enstore info --show-copies CDMS123800281300002

  CDMS115788240600000       ENDEV        LTO3        LTO3     TEST85
0000_000000000_0000001            no      5290065920      3951343656
000200000000000003DD20
/pnfs/data2/sl8500/fcdfcaf566/fcdfcaf566_4000_1157882036.data
  CDMS123800281300002       ENDEV        LTO3        LTO3     TEST21
0000_000000000_0000001            no      5290065920      3951343656
000200000000000004C4D8
/pnfs/data2/sl8500/fcdfcaf566/fcdfcaf566_4000_1157882036.data
```

See also **encp--copies**; **enstore info --find-all-copies**, **--find-copies**, **--find-original**, --**find-the-original**, **--show-copies** and **--show-file** for more information.

--show-file <BFID>
Display information about the file specified by its BFID and some information about the volume where the file is located. The columns are the BFID, Storage Group, Library, Media Type, Label, Deleted Status, Size, CRC, PNFS ID and Original PNFS Path.

```
$ enstore info --show-file GCMS125028149900000

  GCMS125028149900000         gcc        LTO3        LTO3     TEST11
0000_000000000_0006692         yes              2532     3516567016
```

```
        000100000000000045BC440
        /pnfs/fnal.gov/testers/NULL/20090814-213844-23461-0.txt
```

See also **enstore info --bfid** and**--show-copies** for more information.

--usage
Prints short help message. Example:

```
$ enstore info --usage
```

```
    Usage:
           info [ -h --bfid= --help --list= --ls-active= --usage ]
```

--vol <VOLUME_NAME>
Returns detailed information about specified volume
Example:

```
$ enstore info --vol VO3332
```

```
    {'blocksize': 131072,
     'capacity_bytes': 64424509440L,
     'declared': 1011219237.849051,
     'eod_cookie': '0000_000000000_0000044',
     'external_label': 'VO3332',
     'first_access': 1021053575.259737,
     'last_access': 1067315745.238969,
     'library': '9940',
     'media_type': '9940',
     'non_del_files': 43,
     'remaining_bytes': 1785262080L,
     'sum_mounts': 234,
     'sum_rd_access': 213,
     'sum_rd_err': 0,
     'sum_wr_access': 43,
     'sum_wr_err': 0,
     'system_inhibit': ['none', 'full'],
     'user_inhibit': ['none', 'none'],
     'volume_family': 'cms.objy_data_files.cpio_odc',
     'wrapper': 'cpio_odc'}
```

--vols
or
--vols <VOLUME_STATUS>
or
--vols <KEY> <VALUE>
Lists all volumes with their available space, the system inhibits, the library, the volume family (period-separated concatenation of storage group, file family and file family wrapper) and any comments.
The VOLUME_STATUS argument is optional. If left off, all volumes are listed. Possible values for this argument include: NOACCESS, NOTALLOWED, full, read_only, migrated.
The KEY option accepts: storage_group, library and media_type
Example:

```
$ enstore info --vols

    label          avail.    system_inhibit      library    vol_family
    comment

    ...

    VO0053            1.19GB      (none      full   )            eagle
    cms.objy_data_files.cpio_odc

    VO0054            0.51GB      (none      full   )            eagle
    cms.objy_data_files.cpio_odc

    VO0055            0.17GB      (none      full   )            eagle
    theory.theory-canopy-C.cpio_odc

    VO0056            0.65GB      (none      full   )            eagle
    theory.theory-canopy-D.cpio_odc

    ...
```

8.2 enstore library

This command communicates with the Library Manager (see section 8.3 *Library Manager*). You can use it to get information pertaining to a particular Library Manager. Use the online monitoring pages (see Chapter 10: *Monitoring Enstore on the Web*) to find the library manager of interest.
Syntax:

```
% enstore library [--option [argument] ... ] <library>
```

The **<library>** argument is required except when using the **--help** option; the "**.library_manager**" portion of the library name is optional.
Options:

-h, --help
Prints this message (i.e., prints the options). Example:

```
$ enstore library --help
```

```
Usage:
       library [OPTIONS]... library


       --get-asserts <library> print sorted lists of pending volume
asserts
         --get-queue <HOST_NAME>  print queue submitted from the
specified host.
                                  If empty string specified, print the
whole queue
       --get-suspect-vols    print suspect volume list
         --get-work-sorted      print sorted lists of pending and
active requests
   -h, --help                prints this messge
       --usage               prints short help message
```

--get-asserts <LIBRARY>
Prints sorted lists of pending volume asserts for specified library. Example:

```
$ enstore library --get-asserts
  9940.library_manager
```

```
Pending assert requests: 0
Active assert requests: 0
{'status': ('ok', None)}
```

--get-queue <HOST_NAME> <LIBRARY>
Prints queue submitted from the specified **encp** client host. Both arguments are required. If quoted empty string is specified for host name, it prints the whole queue (for all hosts). Examples:

```
$ enstore library --get-queue stkensrv3
  9940.library_manager

  Pending write requests
  Active requests
  Pending read requests:  0
  Pending write requests:  2
  Active read requests:  0
  Active write requests:  0
  {'status': ('ok', None)}
```

The top two lines tell us that there are no pending or active transfers involving stkensrv3 for the 9940 library manager. The 4th line tells us there are 2 pending write requests for this library manager from hosts other than stkensrv3.
If all hosts are specified (the next example), the command returns the fields: host name, library manager, username (of **encp** request), input filename, and output filename for each pending and/or active request (3 shown here), and ends with a summary:

```
$ enstore library --get-queue ""
  9940.library_manager

  Active requests
  fnsimu2 9940.library_manager lixn
     /pnfs/btev/geant2003/xiaonan/dstar_xiaonan_1.evt.gz
     /scr/bphys6/lixn/dstar_xiaonan_1.evt.gz M 9944
  fsgi01 9940.library_manager rschultz
     /usr/bdms/rschultz/fl_066_uplsr7/fl_ed_066_uplsr7.ldhi
     /pnfs/BDMS/lens/fl_066_uplsr7/fl_ed_0663
  fnsfh 9940.library_manager minfarm
     /export/stage02_minos/C00040259_0000.tdaq.root
     /pnfs/minos/caldet_reco/tdaq_data/2002-09/C0004027
  Pending read requests:  0
  Pending write requests:  0
  Active read requests:  1
  Active write requests:  2
  {'status': ('ok', None)}
```

--get-suspect-vols <LIBRARY>
Prints suspect volume list for specified library manager. See 10.6.1 *Suspect Volumes*. Example:

```
$ enstore library --get-suspect-vols
  9940.library_manager

  [{'movers': ['994071.mover'], 'external_label': 'VO4523',
```

```
'time':     1067290586.907726},     {'movers':     ['994051.mover',
'994061.mover', ']
```

--get-work-sorted <LIBRARY>
Prints sorted lists of pending and active requests. It sorts by queue. Example:

```
$ enstore library --get-work-sorted
  9940.library_manager

  {'write_queue': [], 'read_queue': [], 'admin_queue': []}
  [{'status': ('ok', None), 'vc': {'status': ('ok', None),
  'declared':  1011741604.130481,  'si_time':  [1041612783.99499,  0],
  'blocksiz]
```

8.3 enstore monitor

This command communicates with the Monitor Server (see Chapter 10: *Monitoring Enstore on the Web*) to get network speed information.
On machines with an `enstore.conf` file (see Appendix A: *Network Control*), the **`enstore monitor`** command uses the routing already established there. If **`enstore monitor`** set up its own, it would interfere with the routes currently in use.
Syntax:

```
% enstore monitor [--option [argument] ...]
```

-h, --help
Prints this message (i.e., prints the options). Example:

```
$ enstore monitor -h
Usage:
       monitor [ -h --help --host= --usage --verbose= ]

   -h, --help                prints this messge
       --host <HOSTIP>       selects a single host
       --port <PORT>         selects a port
       --usage               prints short help message
       --verbose <VERBOSE>   print out information.
```

--host [HOST_NAME or IP_ADDRESS]
Returns network rate for the specified host (Enstore node). If you don't specify host, it runs the command for all hosts. Example below shows results for a single host. Example:

```
$ enstore monitor --host stkensrv3

    Trying stkensrv3.fnal.gov
    Network rate measured at 11.33 MB/S recieving and 11.1 MB/S
    sending.
```

--port <PORT>
Selects the specified port. If you don't specify port, it runs the command for the default port.

--verbose <INTEGER_VALUE>
This command is used to help find and fix network problems. It prints detailed information about actions taken. The higher the number you give as an argument, the more info displayed. Example:

```
$ enstore monitor --host stkensrv3 --verbose 20

    6 Tue Oct 28 10:48:13 2003 msc called with args: ['monitor',
    '--host', 'stkensrv3', '--verbose=20']
    13 Tue Oct 28 10:48:13 2003 Get monitor_server config info from
    server
    Trying stkensrv0.fnal.gov
    13 Tue Oct 28 10:48:13 2003 Get None config info from server
    13 Tue Oct 28 10:48:13 2003 Get None config info from server
    13 Tue Oct 28 10:48:13 2003 Get log_server config info from server
    13 Tue Oct 28 10:48:13 2003 Get log_server config info from server
    13 Tue Oct 28 10:48:13 2003 Get None config info from server
    13 Tue Oct 28 10:48:13 2003 Get alarm_server config info from
    server
    ...
    10 Tue Oct 28 10:48:14 2003 Connecting to monitor server.
    10 Tue Oct 28 10:48:14 2003 Obtaining error status for data socket.
    10 Tue Oct 28 10:48:15 2003 Get the final dialog rate information.
    Network rate measured at 11.34 MB/S recieving and 11.23 MB/S
    sending.
```

8.4 enstore pnfs

Enstore has a **`pnfs`** command that allows you to retrieve a variety of information, as listed in the option table below. Off-site users cannot mount `/pnfs`, and therefore cannot run this command.

☞ Using this command to perform PNFS manipulations and/or change PNFS tags is restricted to Enstore administrators and/or their designated gurus, and is covered in Appendix B: *Changing PNFS Tags*.

Syntax:

```
% enstore pnfs [--option [argument] ... ]
```

--help
List the options for the **`enstore pnfs`** command. Example:

```
% enstore pnfs --help
```

```
Usage:
       pnfs [OPTIONS]...

       --bfid <FILENAME>     lists the bit file id for file
       --cat <FILENAME> [LAYER]  see --layer
       --file-family [FILE_FAMILY]  gets file family tag, default; sets
file
                             family tag, optional
        --file-family-width [FILE_FAMILY_WIDTH]  gets file family width
tag,
                             default; sets file family tag, optional
         --file-family-wrapper [FILE_FAMILY_WRAPPER]  gets file family
width tag,
                             default; sets file family tag, optional
       --filesize <FILE>     print out real filesize
   -h, --help                prints this messge
       --info <FILENAME>     see --xref
       --layer <FILENAME> [LAYER]  lists the layer of the file
        --library [LIBRARY]   gets library tag, default; sets library
tag,
                             optional
       --tag <TAG> [DIRECTORY]  lists the tag of the directory
        --tagchmod <PERMISSIONS> <TAG>  changes the permissions for the
tag; use
                             UNIX chmod style permissions
         --tagchown <OWNER> <TAG>  changes the ownership for the tag;
OWNER can
                             be 'owner' or 'owner.group'
       --tags [DIRECTORY]    lists tag values and permissions
       --usage               prints short help message
       --xref <FILENAME>     lists the cross reference data for file
```

--bfid <FILE_NAME>
Returns the BFID of the file; select file name to specify from within pnfs space and use relative/absolute path as needed.
Example:

```
$ enstore pnfs --bfid /pnfs/mist/zuu/100MB_002
```

```
WAMS104102942800000
```

--cat <PATH_TO_FILE> [LAYER]
--cat is an alias for --layer; see --layer.

--file-family
Prints the file family name associated with the current pnfs directory. Example:

```
$ enstore pnfs --file-family
    dcache
```

--file-family-width
Prints the file family width associated with the current pnfs directory. Example:

```
$ enstore pnfs --file-family-width
    1
```

--file-family-wrapper
Prints the file family wrapper associated with the current pnfs directory. Example:

```
$ enstore pnfs --file-family-wrapper
    cpio_odc
```

--filesize <PATH_TO_FILE>
Prints the real filesize in bytes; useful for files of size greater than (2G-1) bytes, since PNFS stores file size as 1 in this case. Example:

```
$ enstore pnfs --filesize a01
    24198
```

--info <PATH_TO_FILE>
Prints information about the file, this is an alias for the --xref option. See --xref.

--layer <PATH-TO-FILE> <LAYER>
Prints information about the file. Layer 0 is used internally by pnfs and it can't be viewed. Layer 1, the default, gives the file's BFID. Layer 2 is used by dCache. Layers 3, 5, 6, 7 are not currently used. Layer 4 produces output equivalent to --xref, but returns info without field labels.
The option --cat is an alias for this option.
Examples:
Layer 1 gives BFID (default):

```
$ enstore pnfs --layer a01
    CDMS105889726300000
$ enstore pnfs --layer a01 1
    CDMS105889726300000
```

Layer 2 is used for dCache:

```
$ enstore pnfs --layer a01 2
    2,0,0,0.0,0.0
    :c=1:d15ef6a3;l=554423;
    w-fcdfdata018-1
```

The file has a version1 crc of c=1:d15ef6a3, it has a length l=554423, and it is in pool w-fcdfdata018-1.

```
$ enstore pnfs --layer a01 2
    2,0,0,0.0,0.0
    :
```

Layer 4 gives --xref output (see --xref):

```
$ enstore pnfs --layer a01 4
    VO3222
    0000_000000000_0006264
    24198
    dcache
    /pnfs/fs/usr/test/xyz/srmtest/test_1_1/a01

    000500000000000000191030

    CDMS105889726300000
    stkenmvr5a:/dev/rmt/tps3d1n:4560000022
```

--tags [DIRECTORY]
List the tag values of specified PNFS directory (if no directory argument, it lists tags for current working directory (cwd or pwd)).
Example:

```
$ pwd
    /pnfs/test/xyz/srmtest/test_1_1
$ enstore pnfs --tags
    .(tag)(file_family) = dcache
    .(tag)(file_family_width) = 1
    .(tag)(file_family_wrapper) = cpio_odc
    .(tag)(library) = 9940
    .(tag)(storage_group) = test
    -rw-rw-r--   11 root     sys            6 Jul 26  2001
                     /pnfs/test/xyz/srmtest/test_1_1/.(tag)(file_family)
    -rw-rw-r--   11 root     sys            1 May  5  2000
                                    /pnfs/test/xyz/srmtest/test_1_1/.(tag)
    (file_family_width)
    -rw-rw-r--   11 root     sys            8 May  5  2000
                                    /pnfs/test/xyz/srmtest/test_1_1/.(tag)
    (file_family_wrapper)
    -rw-rw-r--   11 root     sys            4 Jul  3 10:59
                     /pnfs/test/xyz/srmtest/test_1_1/.(tag)(library)
    -rw-r--r--   11 root     sys            4 Jul 26  2001
                     /pnfs/test/xyz/srmtest/test_1_1/.(tag)(storage_group)
```

(minor reformatting done to enhance readability)

--xref <FILE_NAME>
List cross-reference information (metadata) for specified file. (--info is an alias for --xref.) The information includes:

- volume: storage media volume label
- location cookie: file position on tape (the number of the file on tape)
- size: file size in bytes
- file family: file family
- original name: original name in `/pnfs` before any move/copy command issued; i.e., the destination filename given in the **`encp`** command used to copy the file to Enstore
- map file: obsolete, but some older files may have a value here
- pnfsid file: unique id for the file as assigned by PNFS
- pnfsid map: obsolete, but some older files may have a value here
- bfid: unique id for the file as assigned by Enstore (matches layer 1)
- origdrive: id of drive used when file was written to media (files generated prior to 10/2000, **encp** v2_5 or earlier, will not have a value here)
- crc: CRC of the file (appears for files after 10/2003, using **encp** v3_1 or greater)

Example:

```
$ enstore pnfs --xref a01

    volume: VO3222
    location_cookie: 0000_000000000_0006264
    size: 24198
    file_family: dcache
    original_name: /pnfs/fs/usr/test/xyz/srmtest/test_1_1/a01
    map_file:
    pnfsid_file: 000500000000000000191030
    pnfsid_map:
    bfid: CDMS105889726300000
    origdrive: stkenmvr5a:/dev/rmt/tps3d1n:4560000022
    crc: unknown
```

--library
Returns the value of the library tag (the virtual library associated with files in the directory) for the current pnfs directory. Example:

```
$ enstore pnfs --library

    9940
```

8.5 enstore file (deprecated)

This command has been deprecated for users as of **encp** v3_2, and (along with **`enstore volume`**) replaced with **`enstore info`** (see section Error: Reference source not found).

This command communicates with the File Clerk (see section 8.1 *File Clerk*). It returns information about a specified file or files on a specified volume.

Syntax:

```
% enstore file [--option [argument] ... ]
```

Options:

-h, --help
Prints the options (i.e., prints this message). Example:

```
$ enstore file --help
    Usage:
           file [ -h --bfid= --help --list= --ls-active= --usage ]

           --bfid <BFID>         get info of a file
       -h, --help                print this message
           --list <VOLUME_NAME>  list the files in a volume
           --ls-active <VOLUME_NAME>  list active files in a volume
           --show-bad            lists all bad files
           --usage               print short help message
```

--bfid <BFID>
Returns information (metadata) about the file corresponding to the specified bfid.
You can get the bfid of a file from the **`enstore pnfs --bfid <FILE_NAME>`** command (section Error: Reference source not found); get the filename from searching PNFS namespace.
Example:

```
$ enstore file --bfid CDMS105770745000000
    {'bfid': 'CDMS105770745000000',
     'complete_crc': 1191066979L,
     'deleted': 'no',
     'drive': 'stkenmvr7a:/dev/rmt/tps0d1n:4560000022',
     'external_label': 'VO3222',
     'location_cookie': '0000_000000000_0005661',
     'pnfs_mapname': '',
                                                          'pnfs_name0':
    '/pnfs/fs/usr/test/xyz/srmtest/ar017983.0001phys_10',
     'pnfsid': '000500000000000000190EA8',
     'pnfsvid': '',
```

```
        'sanity_cookie': (65536L, 3203712884L),
        'size': 197354833L}
```

--list <VOLUME_NAME>
Lists the files in the specified volume with their volume name, bfid, size, location (file number) on volume, delete flag, and the original filename in pnfs.
You can get the volume name from the **`enstore pnfs`** command, using either **`--xref`** or **`--layer`** (section Error: Reference source not found), or from the "external_label" field of the **`enstore file --bfid <BFID>`** command (shown above).
The **`enstore info --list <VOLUME_NAME>`** is an alias for this command.
Example:

```
$ enstore file --list VO3222

    label  bfid               size   location_cookie        delflag
    original_name

    VO3222 CDMS106503213600000 983803 0000_000000000_0011536 deleted
    /pnfs/fs/usr/eagle/dcache-tests/274.dcache_page_p_27750
```

(This shows one of many lines appearing in the real output, and is reformatted to two lines for readability.)

--ls-active <VOLUME_NAME>
Lists active files in a volume.
You can get the volume name from the **`enstore pnfs`** command, using either **`--xref`** or **`--layer`** (section Error: Reference source not found), or from the "external_label" field of the **`enstore file --bfid <BFID>`** command (shown above).
Example:

```
$ enstore file --ls-active VO3222

    /pnfs/fs/usr/eagle/dcache-tests/101.dcache_page_a_24401
    /pnfs/fs/usr/eagle/dcache-tests/101.dcache_page_24401
    /pnfs/fs/usr/test/stress-test/myfile1
    /pnfs/fs/usr/test/stress-test/myfile3
    /pnfs/fs/usr/test/stress-test/file128m-11
    ...
```

--show-bad
Lists all files that are currently unavailable due to media problems. When a tape problem is discovered, the tape is sent to the vendor for file recovery. In the interim, a cloned tape is made available to users, with the bad files marked. This command option lets you list the bad files. The output lists the tape number, BFID, file size in bites, and pnfs path of file.
Example:

```
$ enstore info --show-bad

    ...
    VO0053 CDMS105770745000000 95530315
     /pnfs/fs/usr/xyz/my_data/2004-4/.bad.F000xyz43_0000.mdaq.root
    ...
```

We show only one output line, and it is displayed on two lines for readability. Notice the "`.bad.`" at the front of the filename; this is how the bad files are marked.
Replaced by: **`enstore info --show-bad`**.

--usage
Prints short help message. Example:

```
$ enstore file --usage

    Usage:
           file [ -h --bfid= --help --list= --ls-active= --usage ]
```

8.6 enstore volume (deprecated)

This command has been deprecated for users as of **encp** v3_2, and replaced (along with **`enstore file`**) with **`enstore info`** (see section Error: Reference source not found).

This command communicates with the Volume Clerk (see section 8.2 *Volume Clerk*) to return information on data volumes.

Syntax:

```
% enstore volume [--option [argument] ... ]
```

-h, --help
Prints this message (i.e., prints the options). Example:

```
$ enstore volume --help
    Usage:
           volume [OPTIONS]...

           --gvol <VOLUME_NAME>  get info of a volume in human readable
    time
                                 format
       -h, --help                prints this messge
           --just <VOLUME_NAME>  used with --pvols to list problem
           --list <VOLUME_NAME>  list the files in a volume
           --ls-active <VOLUME_NAME>  list active files in a volume
           --ls-sg-count         list all sg counts
           --pvols               list all problem volumes
           --usage               prints short help message
           --vol <VOLUME_NAME>   get info of a volume
           --vols                list all volumes
```

--gvol <VOLUME_NAME>
This is just like **`enstore volume --vol <VOLUME_NAME>`**, except that this one prints human-readable time fields (e.g., “declared”, “first_access” and “last_access” fields). Example:

```
$ enstore volume --gvol VO3332
```

```
{'blocksize': 131072,
 'capacity_bytes': 64424509440L,
 'declared': 'Wed Jan 16 16:13:57 2002',
 'eod_cookie': '0000_000000000_0000044',
 'external_label': 'VO3332',
 'first_access': 'Fri May 10 12:59:35 2002',
 'last_access': 'Mon Oct 27 22:35:45 2003',
 'library': '9940',
 'media_type': '9940',
 'non_del_files': 43,
 'remaining_bytes': 1785262080L,
 'sum_mounts': 234,
 'sum_rd_access': 213,
 'sum_rd_err': 0,
 'sum_wr_access': 43,
 'sum_wr_err': 0,
 'system_inhibit': ['none', 'full'],
 'user_inhibit': ['none', 'none'],
 'volume_family': 'cms.objy_data_files.cpio_odc',
 'wrapper': 'cpio_odc'}
```

--just
Used with **`--pvols`** to list problem. See **`enstore volume --pvols`**.

--list <VOLUME_NAME>
This is an alias for the **`enstore info --list <VOLUME_NAME>`** command. See section Error: Reference source not found.

--ls-active <VOLUME_NAME>
Lists original file names of active files in a volume. Example:

```
$ enstore volume --ls-active VO3332
```

```
/
pnfs/cms/UserFederation/data/jetmet_production/data/Collections/jm_
Hit601_g125_UCSD/jm02_qqh120_ll/EVD0.jet0102.DB
/
pnfs/cms/UserFederation/data/jetmet_production/data/TAssoc/jm_2x103
3PUjm602_TkMu_g125_UCSD/jm02_hlt15-20/EVD11.jet0102.DB
/
pnfs/cms/UserFederation/data/jetmet_production/data/Digis/jm_2x1033
PUjm602_TkMu_g125_UCSD/jm02-hlt0-15/EVD12.jet0102.DB
```

```
/
pnfs/cms/UserFederation/data/jetmet_production/data/Hits/jm_Hit601_
g125_UCSD/jm02_hlt230-300/EVD12.jet0102.DB
...
```

--ls-sg-count <VOLUME_NAME>
Lists allocated tape counts by library and by storage group. If "storage group" has value "none", the negative number under "allocated" gives the number of tapes that are available in the robot, but not yet assigned to a storage group.
Example:

```
$ enstore volume --ls-sg-count VO3332
```

```
     library    storage group  allocated
=========================================
       ...
        9940             ktev        189
        9940             lqcd        150
        9940        miniboone        132
        9940            minos        109
        9940             none        -13
        9940          patriot         20
        9940             sdss        608
        9940             test         28
        9940           theory         70
    CD-9940B              cms        129
        ...
```

--pvols [--just <VOLUME_1> <VOLUME_2> ...]
Without **`--just`**, this lists all problem volumes. With **`--just`** followed by a space-separated list of volume names, it lists only the problem volumes among the given list.
The columns returned are: volume name, primary status, primary status time, secondary status, secondary status time. (The time fields are relatively new; not all volumes will display them.)
Example:

`$ enstore volume --pvols`

```
==== readonly
LEGL10             none         *     readonly 0913-1540
LEGL98             none         *     readonly 0819-2329
...
==== full
...
VO4845             none         *         full         *
VO4846             none 1023-1032         full         *
VO4847             none         *         full         *
VO4848             none         *         full         *
VO4849             none         *         full         *
VO4850             none         *         full 1016-2315
VO4851             none         *         full 1017-0409
...
$ enstore volume --pvols --just VO3332
(no sample output available)
```

--vol <VOLUME_NAME>
Returns detailed information about specified volume
Example:

```
$ enstore volume --vol VO3332
```

```
{'blocksize': 131072,
 'capacity_bytes': 64424509440L,
 'declared': 1011219237.849051,
 'eod_cookie': '0000_000000000_0000044',
 'external_label': 'VO3332',
 'first_access': 1021053575.259737,
 'last_access': 1067315745.238969,
 'library': '9940',
 'media_type': '9940',
 'non_del_files': 43,
 'remaining_bytes': 1785262080L,
 'sum_mounts': 234,
 'sum_rd_access': 213,
 'sum_rd_err': 0,
 'sum_wr_access': 43,
 'sum_wr_err': 0,
 'system_inhibit': ['none', 'full'],
 'user_inhibit': ['none', 'none'],
 'volume_family': 'cms.objy_data_files.cpio_odc',
 'wrapper': 'cpio_odc'}
```

--vols
Lists all volumes with their available space, the system inhibits, the library, the volume family (period-separated concatenation of storage group, file family and file family wrapper) and any comments.
Example:

```
$ enstore volume --vols
```

```
label          avail.    system_inhibit      library    vol_family
comment
...
VO0053            1.19GB      (none      full   )            eagle
cms.objy_data_files.cpio_odc
VO0054            0.51GB      (none      full   )            eagle
cms.objy_data_files.cpio_odc
VO0055            0.17GB      (none      full   )            eagle
theory.theory-canopy-C.cpio_odc
VO0056            0.65GB      (none      full   )            eagle
theory.theory-canopy-D.cpio_odc
...
```

Chapter 9: Monitoring Enstore on the Web

There are several installed Enstore systems at Fermilab. Currently these include STKEN for general Fermilab users, CDFEN for CDF RunII, and D0EN for D0 RunII. For each Enstore system, a separate but structurally identical series of web pages is available for monitoring the system and any jobs you've submitted to it. The currently implemented websites for Enstore monitoring include:

- `http://www-stken.fnal.gov/enstore/enstore_system.html` for STKEN
- `http://www-cdfen.fnal.gov/enstore/enstore_system.html` for CDFEN
- `http://www-d0en.fnal.gov/enstore/enstore_system.html` for D0EN

We recommend that you bookmark the appropriate one in your browser.
In this section, we briefly describe the format and function of the web pages that are of interest to users, and show you how to navigate them.
The Enstore pages present snapshots of the status of various components of the Enstore system, and the pages are updated and refreshed periodically. The auto-refresh time interval varies from page to page, and does not correspond with the information update interval, which also varies from page to page. See the online help screens for more detailed information.

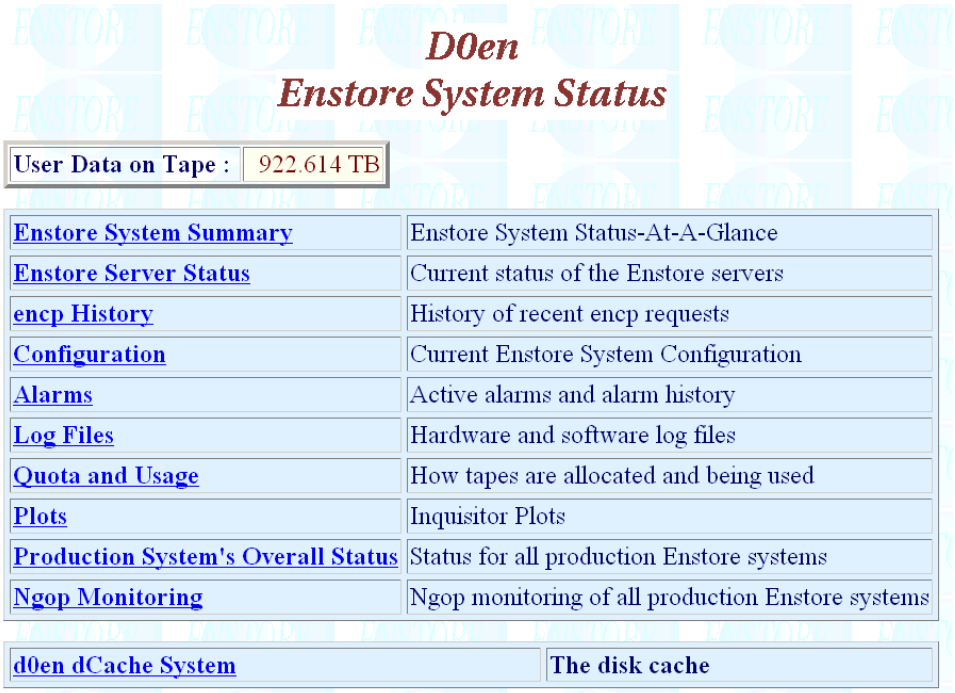
☞ Note for Netscape users: Links on these pages are intended to take you straight to the item of interest, not to the top of the page on which it's found. Due to a Netscape bug, you'll find yourself at the top of the target page. To get to the item of interest, place your cursor in the URL area of the browser and hit **ENTER**.

9.1 Top Page

The top page for monitoring an Enstore system is located at `http://www-<xyz>en.fnal.gov/enstore/` (where `<xyz>` is one of `stk`, `cdf` or `d0`), as given above. This page has two sections, each containing links to other pages.

9.1.1 Enstore System Status Links

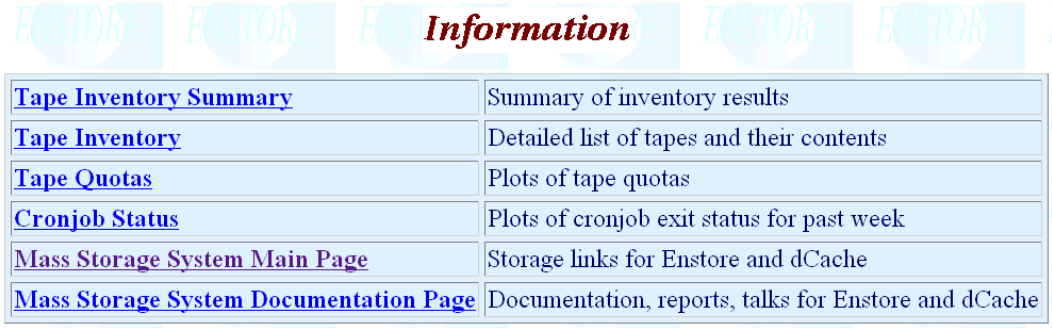
The links under the *Enstore System Status* heading lead to status web pages for the Enstore system and its servers, shown here for the D0en system:



The pages to which these links point (with the exceptions of *Quota and Usage* and *Production System's Overall Status*[15]) share a header format, described in section Error: Reference source not found.

9.1.2 Information

Under the *Information* header are links for finding help, documentation, and so on.

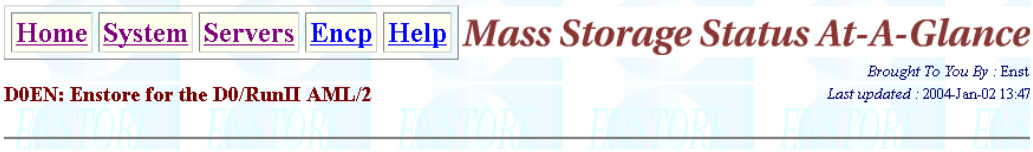


9.2 Header Format for Status pages

Here we see the header for the **Mass Storage Status At-A-Glance** page (from

15 *Quota and Usage* links to a text file with no header; and *Production System's Overall Status* has the header elements on the right-hand side only.

the link “Enstore System Summary” on the top page):



Header elements:

- In the upper-right corner you’ll find the page title, **Mass Storage Status At-A-Glance**, in this case.
- Underneath the page title is the name of the Enstore server that created this web page (e.g., Enstore), and the date and time that the current page was created. If the time shown here is more than a few minutes earlier than the current time, you should refresh your browser window to get updated information.
- The buttons in the upper-left corner are quick links to different pages:
  - **Home** the top page, described in section Error: Reference source not found
  - **System** the **Status At-A-Glance** page, described in section Error: Reference source not found (the page associated with the “Enstore System Summary” link on the top page; it is the page shown in the above image)
  - **Servers** the **Enstore Server Status** page, described in section Error: Reference source not found (the page associated with the “Enstore Server Status” link on the top page)
  - **Encp** the **Encp History** page, described in section Error: Reference source not found (the page associated with the “encp History” link on the top page)
  - **Help** page-specific online help
- Underneath these buttons you’ll find the Enstore system identifier; in the above image, it is *D0EN: Enstore for the D0/RunII AML/2*.

9.3 Mass Storage Status-At-A-Glance Page

What? The **Status-At-A-Glance** page presents summarized information indicating which parts of the Enstore system are up and working, which parts have problems, which have a scheduled outage, and other system information. It also provides a mapping between Enstore servers and the nodes that run them.

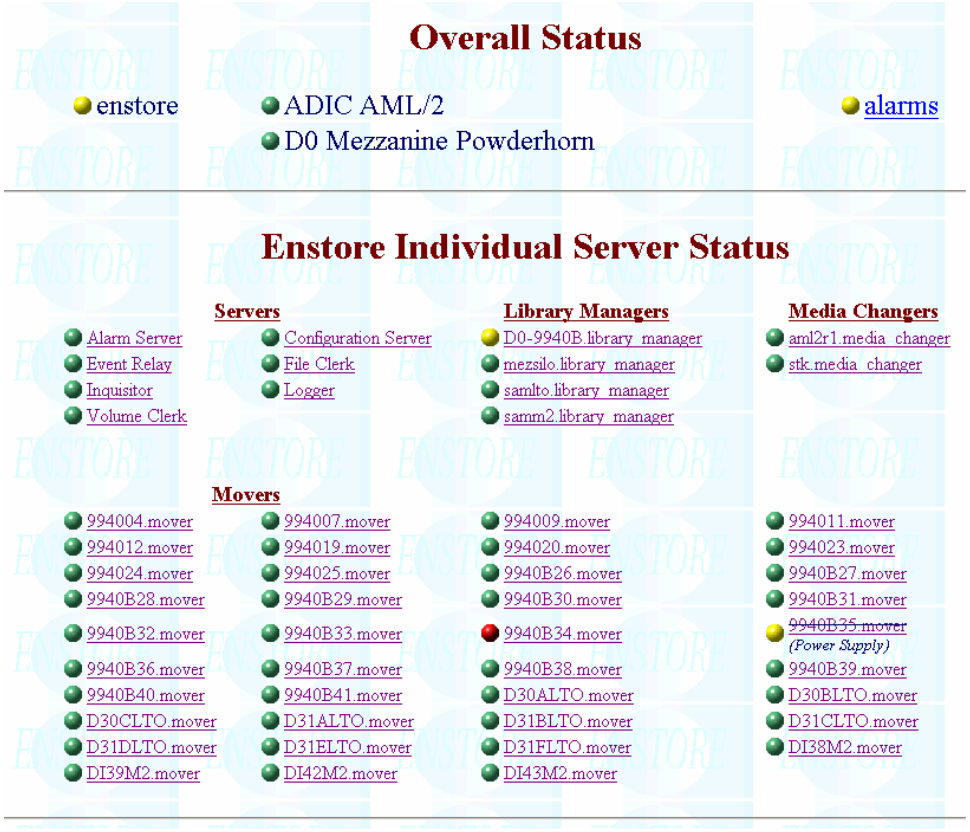
Why? Start at this page when investigating any possible problem. This page indicates which if any components of your Enstore system are experiencing problems.

How? To arrive at this page, start at the top page and click "Enstore System Summary", or click the **SYSTEM** button on any of the pages.

The Enstore components and servers listed on this page are described in Chapter 8: *Overview of the Enstore Servers*.

Page Description

The page is divided into three sections. They list systems and servers, and code them with colored ball icons to indicate their status. The **HELP** button at the top of the page (see section Error: Reference source not found) describes the status icons.



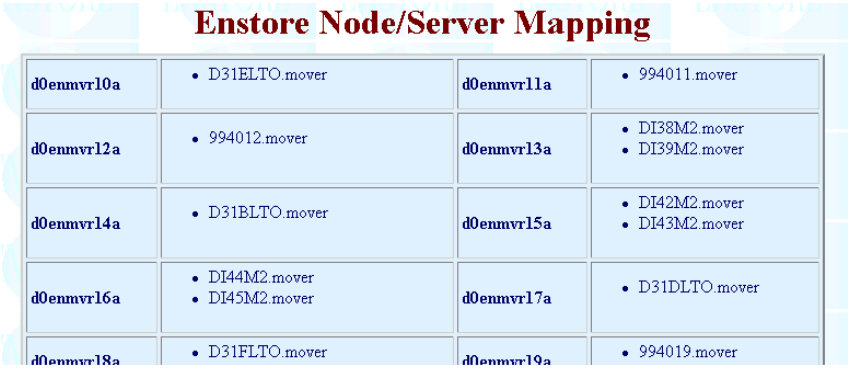
Enstore Overall Status summarizes the status (from left to right) of Enstore as a whole, the tape robots, the network, and alarm components. There is only one link:

The “alarms” link takes you to the **Enstore Active Alarms** page described in section Error: Reference source not found.

Enstore Individual Server Status

lists all servers (Chapter 8), library managers (section 8.3), movers (section 8.4), and media changers (section 8.5); includes individual status indicators. Each link in this section takes you to its corresponding server entry on the page described in section Error: Reference source not found.

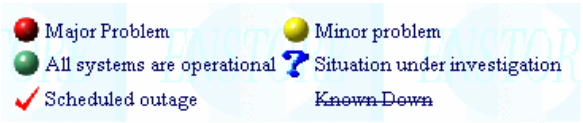
Status indicators do not apply to the third section, which lists the nodes in the Enstore system and the servers that run on each of them (below we show the first few rows of the table). There is no status information.



Enstore Node/Server Mapping

d0enmvr10a	• D31ELTO.mover	d0enmvr11a	• 994011.mover
d0enmvr12a	• 994012.mover	d0enmvr13a	• DI38M2.mover • DI39M2.mover
d0enmvr14a	• D31BLTO.mover	d0enmvr15a	• DI42M2.mover • DI43M2.mover
d0enmvr16a	• DI44M2.mover • DI45M2.mover	d0enmvr17a	• D31DLTO.mover
d0enmvr18a	• D31FLTO.mover	d0enmvr19a	• 994019.mover

There is a legend at the bottom of the page for the status icons which looks like this:



9.4 Enstore Server Status

What? As the page title implies, the **Enstore Server Summary** page provides the status of all the Enstore servers included in your system. This includes movers, library managers, and so on. The servers are described in Chapter 8: *Overview of the Enstore Servers*.

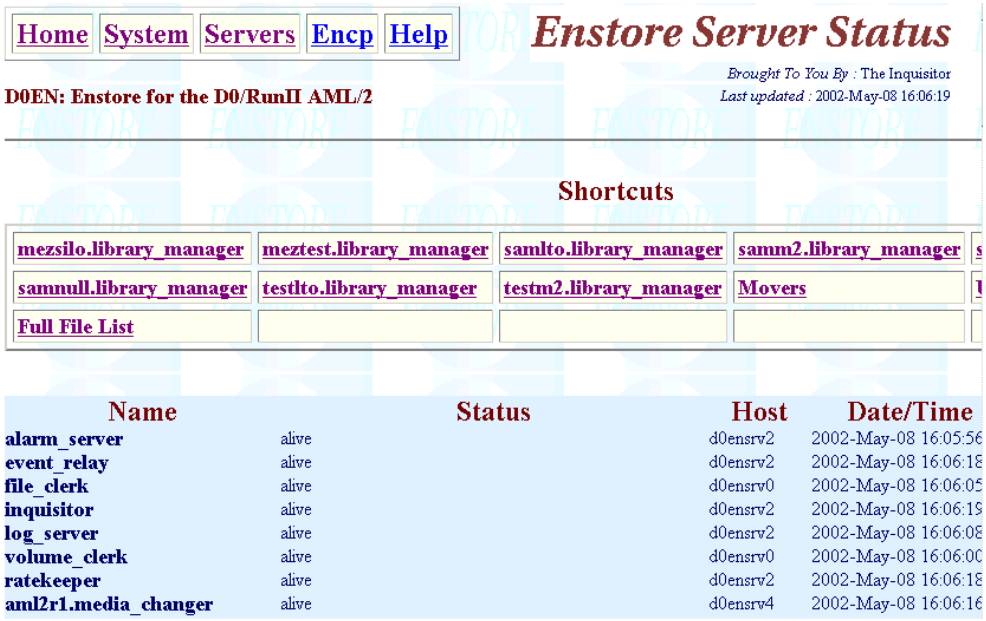
Why? Use this page to find out what a particular server is currently doing,

and what work it has pending.

How? To arrive at this page, start at the top page and click “Enstore Server Status”, or click the **SERVERS** button on any of the pages.

Page Description

The page is divided into two sections.

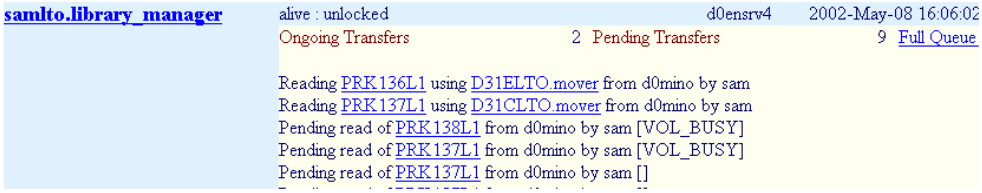


The first section, *Shortcuts*, is simply a compilation of links that point to anchors in the table that comprises the second section. There is also a link labelled “Full File List” which takes you to the **Active File List** page, described in section Error: Reference source not found (useful for tracking down the library managers associated with the file you want to investigate if you only know the name of the file).
The second (and main) section is a status table which lists all the servers, and displays the server name, status, host, date/time, and last time alive for each. Some server names and status information in this table have links to pages with more information. We define the statuses below by server type.
This page is updated and refreshed periodically.

- The link on a library manager (LM) name points to the **Library Manager Queues** page for the corresponding LM (see section Error: Reference source not found).
- The link “Full Queue Elements” points to the **Full Library Manager**

Info page (see section Error: Reference source not found).

- The link on a volume name takes you to a text page with the volume's inventory information (see section Error: Reference source not found).



Statuses for library managers (LM) include:

`alive : unlocked`

LM is working normally

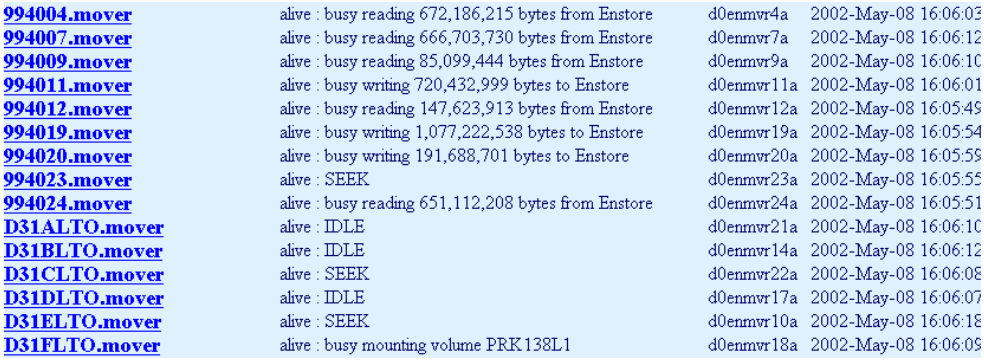
`alive: locked` LM is rejecting new **encp** requests, but continues to assign jobs already in the pending queue to movers; **encp** does not retry

`alive: nowrite` LM is locked for write requests

`alive: noread` LM is locked for read requests

`alive: ignore` LM is ignoring new **encp** requests (returning "ok" to **encp**), but continues to assign jobs already in the pending queue to movers; **encp** retries internally so user is unaware of the delay

The link on a mover name points to the corresponding mover (MV) on the **Movers** page (described in section Error: Reference source not found).



`alive : IDLE` MV is idle because there are no jobs to process

`alive : SETUP` MV is in initial phase of a job, it is setting up a connection with **encp** for a transfer

`alive: busy mounting volume <volname>`

MV is waiting for the media changer to finish mounting a tape; the

volume name is given

`alive : SEEK` a tape is mounted, and the correct read or write location on the tape is being located

`alive : busy reading/writing <n> bytes from/to Enstore`

MV is reading data from Enstore, or writing data to Enstore; the number of bytes read or written so far is given

`alive : busy dismounting volume <volname>`

MV is waiting for media changer to finish dismounting a volume; the volume name is given

`alive : HAVE BOUND volume - IDLE`

MV has completed a job but is waiting for a subsequent job for same tape; tape is still in drive

`alive: DRAINING`

MV is completing last job before going offline; it will not accept more jobs

`alive : CLEANING`

a cleaning tape is in the drive; MV cannot accept more jobs until the cleaning has finished.

`alive : OFFLINE`

MV is offline and not accepting jobs (MV name displayed in orange)

`alive : FINISH_WRITE`

MV writing is completed and MV is waiting for file and volume metadata to be created.

`alive : ERROR <text>`

`alive` server is working normally

`timed out` the inquisitor hasn't received the latest "I'm alive" message from the server

`dead` duration of "timed out" status on server has exceeded configured limit (server name appears in orange)

`not monitoring` server is known to the enstore system, but is not currently being monitored by the inquisitor (server name is displayed in gray)

`cant update status`

9.5 Active File List

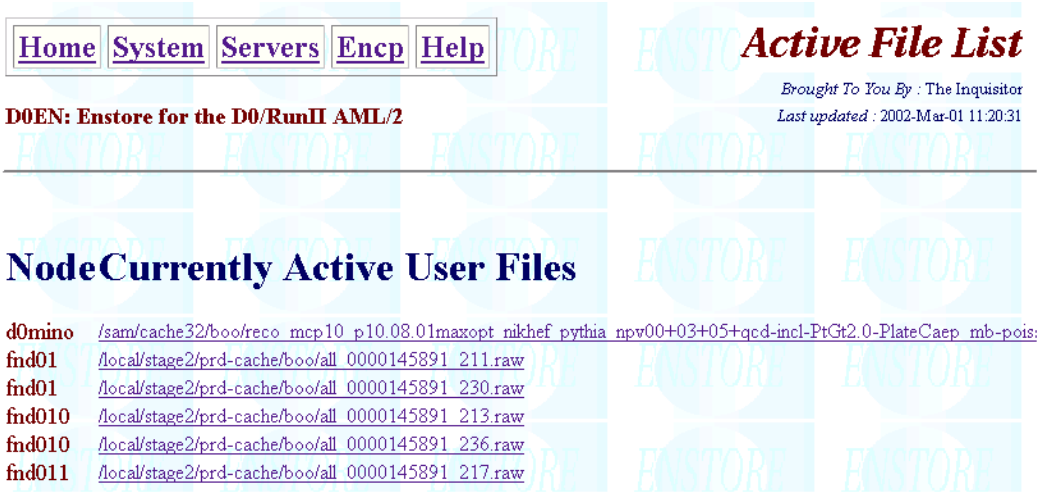
What? The **Active File List** page lists the data files being actively worked on by your Enstore system. The files are listed by user node.

Why? Use this page to find your file. This is the right starting page for checking on your job if you only know the name of the file you're reading or writing (i.e., you don't know the volume or any Enstore server information). This page has links to pages containing more job-related information.

How? To arrive at this page, start at the top page and click "Enstore Server Status". Then under *Shortcuts*, click "Full File List".

Page Description

The files are listed by their full path and name. For each file, the node from/to which it is being read/written is also given. This page doesn't distinguish between read and write.



Scroll as necessary or do a search to find your file in the list and click on it. This will take you to the **Library Manager Queues** page for the library

manager servicing your job; see section Error: Reference source not found.

9.6 Library Manager Queues

What? The **Library Manager Queues** page lists the **encp** jobs that a selected library manager is currently managing or has pending in a queue (**encp** is described in Chapter 6: *Copying Files with Encp*). Movers in states other than busy or IDLE are listed at the bottom of the page (mover statuses are described in section Error: Reference source not found).

Why? Use this page to find out the status of a particular library manager's read and/or write queue(s) once you know which LM is servicing your job. You can find the status of your job, and its priority relative to other jobs in the queue. From this page you can click links to get full details on the processing of your file and on the volume associated with your file.

How? To arrive at this page, follow this string of links starting at the top page. Click "Enstore Server Status", then:

- If you know the filename but not the library manager, then under *Shortcuts*, click "Full File List". Click on your file of interest. This will take you to the **Library Manager Queues** page for the appropriate library manager.
- If you know the library manager, you can click directly on the link in the second section of the **Enstore Server Status** page, instead.

9.6.1 Suspect Volumes

In the case where there are any suspect volumes associated with an LM, this information is displayed on the individual library manager status page.

9.6.2 File Reads

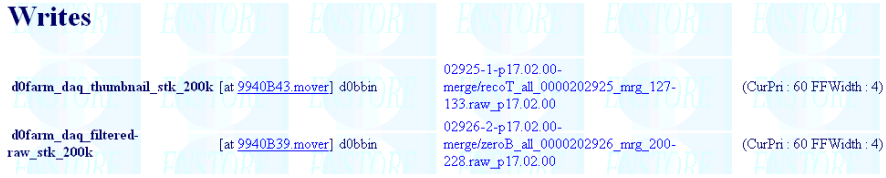
For the *Reads*, files are listed by volume. For each volume in use, the page lists the mover servicing it. Each **encp** job is listed on a separate line. The line lists the host to which the file is to be copied, the last 70 or so bytes of the

filename (filenames can get quite long), the file's current priority in the queue, and the file's position on the tape.

To get full information on the library manager's processing, click *Full Queue Elements* next to *Reads* to arrive at the *Full Library Manager Info* page (described in section Error: Reference source not found). To get full information on a volume being read, click the volume id at the top-left of the queue containing your file. This takes you to the text inventory page for that volume (described in section Error: Reference source not found).

9.6.3 File Writes

Under *Writes*, this page lists write jobs by file family. A mover is listed after the file family for a file only if the file is currently being worked on.



Each file in the write queue appears on a separate line. Each line lists several pieces of information: the host from which the file is to be copied, the last several bytes of the filename (filenames can get quite long), and the current priority and file family width.
The mover name provides a link to the **Movers** page, described in section Error: Reference source not found.

Normally, the number of WRITE jobs running per file family can equal but not exceed the file family width (see section 2.2.2 *File Family Width*). If a READ job is running on a tape that is not marked full, this also counts against the width.


But note: Even if the number of current jobs equals the width, it is possible for a new READ job to start on a tape that's not full (if the tape is marked full, the width is not an issue and the READ job can start anyway) since the width is checked only when assigning WRITE jobs; thus temporarily, the width may be exceeded. Any pending WRITE job must wait until the the number of jobs that count against the width drops below the width value.

9.6.4 Additional Movers

Underneath this information, there may be a table listing additional movers.

Additional Mover	State	Seconds in State	Volume	File Family
9940B26.mover	DISMOUNT_WAIT	39	PRS739	d0farm_daq_thumbnail_stk_200k
9940B32.mover	DISMOUNT_WAIT	4	PRS757	datalogger_stk_200k
9940B36.mover	HAVE_BOUND	25	PRS758	datalogger_stk_200k
9940B41.mover	HAVE_BOUND	10	PRS755	datalogger_stk_200k

Movers that are in any of the following states are listed here (see section Error: Reference source not found for status descriptions):

- CLEANING
- DISMOUNT_WAIT
- ERROR
- HAVE_BOUND
- OFFLINE

Movers not listed anywhere on the page may be assumed to be IDLE, i.e., waiting for a job.

9.7 Full Library Manager Info

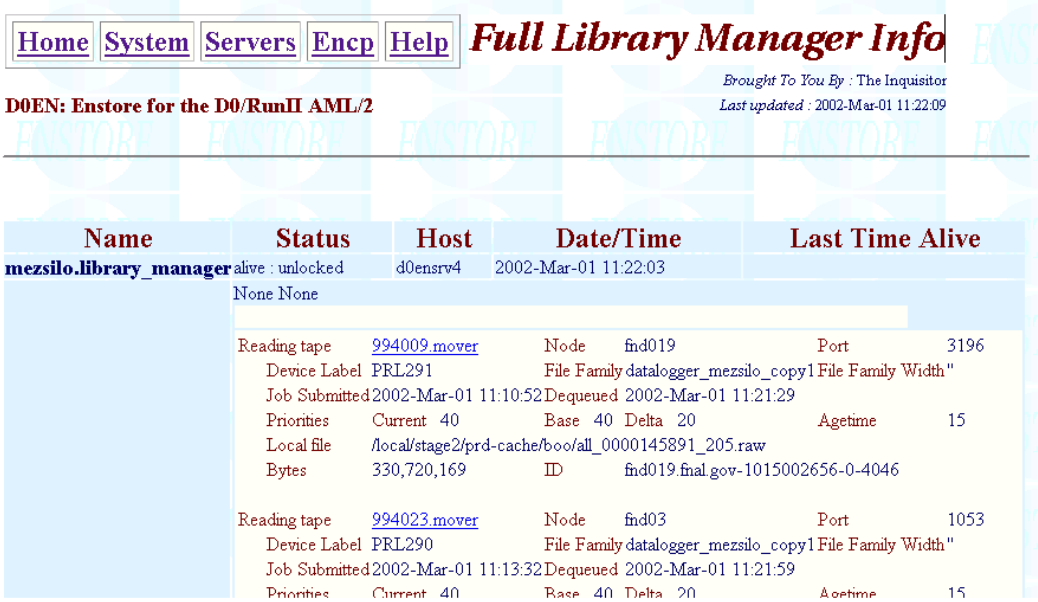
What? The **Full Library Manager Info** page displays the job parameters for each file in a given library manager's current READ and WRITE queues (e.g., local file name, local node, file family, volume ID, priority, etc.).

Why? Use this page to find the status of a READ or WRITE job, e.g., the file's position in the queue, how long it's been in a queue, when it was "dequeued" (i.e., when processing started), and other details about how Enstore is processing it.

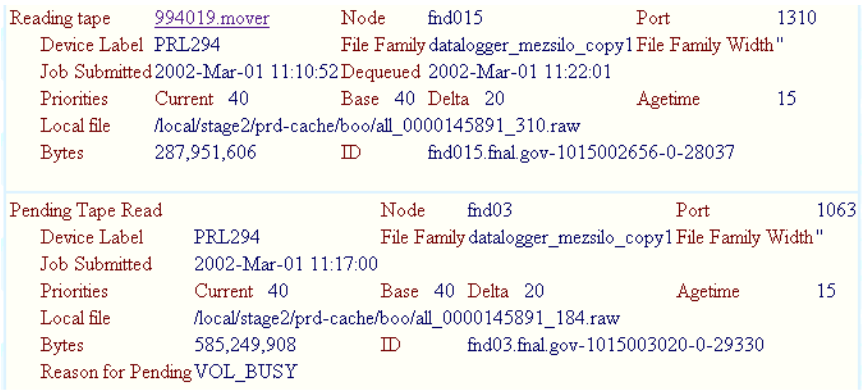
How? To arrive at this page, follow this string of links starting at the top page. Click "Enstore Server Status", find the library manager you want, and click "Full Queue Elements".

If you don't know which LM you want but you know the file, take this route. On the **Enstore Server Status** page under *Shortcuts*, click "Full File List". On the **Active File List** page, click on your file of interest. This will take you to the **Library Manager Queues** page for the appropriate library manager. Here, click "Full Queue Elements" next to *Reads* to come to the **Full Library Manager Info** page. On this page, you can scroll down and locate your file.

Page Description



Your file will appear as one of two types of entries on this page: one type for files being worked on, and another for files pending in the queue.



For those files being worked on, the mover name is given, and it provides a link to the **Movers** page, described in section Error: Reference source not found.

9.8 Tape Inventory Page (Text)

There are a couple of pages that present volume inventory information. One is straight text, discussed in this section. The other page is dynamically generated HTML; see section Error: Reference source not found . The formats of both pages are similar.

What? For each volume declared to your Enstore system, there is a page that presents volume inventory information in straight text format. The page gets updated periodically; be aware that it may not reflect the most recent information.

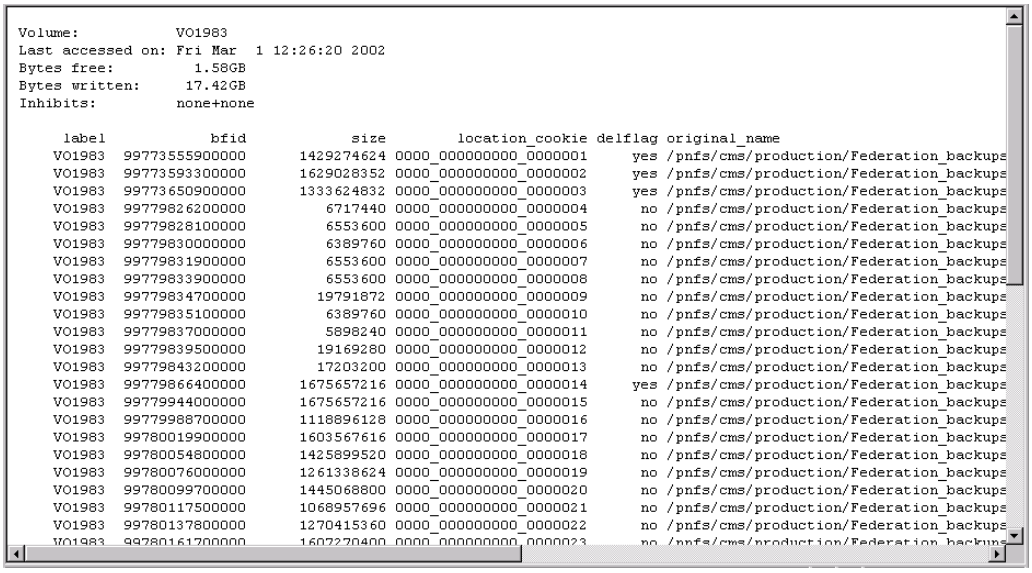
Why? Use this page to find out details of the storage of your file(s) on a volume, to see how full a tape is, or to check the inhibits.

How? *If you only know the filename:* To arrive at the text web page, follow this string of links starting at the top page: click “Enstore Server Status”; then under *Shortcuts*, click “Full File List”. Click on your file of interest. This will take you to the **Library Manager Queues** page for the appropriate library manager. Find your file, and click the corresponding volume ID to come to the inventory page for that volume.

If you know the volume name: To arrive at the text web page, follow this string of links starting at the top page: click “Enstore Server Status”; then look for the volume name listed with one of the active library managers, and click on the volume.

Page Description

At the top of the volume inventory (text) page, you'll find the volume ID, the last accessed date, the number of bytes free, the number of bytes written, and the inhibits (described below).
The volume inventory contains a line for each file on the volume, listed in location order. In addition to the tape label, this page lists the bfid, size, location_cookie, delflag, and original_name (the name given in the **encp** command used to write it). Scroll down to the bottom of the page to find information for the tape volume itself.



```
Volume:           VO1983
Last accessed on: Fri Mar  1 12:26:20 2002
Bytes free:         1.58GB
Bytes written:     17.42GB
Inhibits:          none+none

     label            bfid            size        location_cookie delflag original_name
    VO1983  99773555900000      1429274624 0000_000000000_0000001     yes /pnfs/cms/production/Federation_backups
    VO1983  99773593300000      1629028352 0000_000000000_0000002     yes /pnfs/cms/production/Federation_backups
    VO1983  99773650900000      1333624832 0000_000000000_0000003     yes /pnfs/cms/production/Federation_backups
    VO1983  99779826200000         6717440 0000_000000000_0000004      no /pnfs/cms/production/Federation_backups
    VO1983  99779828100000         6553600 0000_000000000_0000005      no /pnfs/cms/production/Federation_backups
    VO1983  99779830000000         6389760 0000_000000000_0000006      no /pnfs/cms/production/Federation_backups
    VO1983  99779831900000         6553600 0000_000000000_0000007      no /pnfs/cms/production/Federation_backups
    VO1983  99779833900000         6553600 0000_000000000_0000008      no /pnfs/cms/production/Federation_backups
    VO1983  99779834700000        19791872 0000_000000000_0000009      no /pnfs/cms/production/Federation_backups
    VO1983  99779835100000         6389760 0000_000000000_0000010      no /pnfs/cms/production/Federation_backups
    VO1983  99779837000000         5898240 0000_000000000_0000011      no /pnfs/cms/production/Federation_backups
    VO1983  99779839500000        19169280 0000_000000000_0000012      no /pnfs/cms/production/Federation_backups
    VO1983  99779843200000        17203200 0000_000000000_0000013      no /pnfs/cms/production/Federation_backups
    VO1983  99779866400000      1675657216 0000_000000000_0000014     yes /pnfs/cms/production/Federation_backups
    VO1983  99779944000000      1675657216 0000_000000000_0000015      no /pnfs/cms/production/Federation_backups
    VO1983  99779988700000      1118896128 0000_000000000_0000016      no /pnfs/cms/production/Federation_backups
    VO1983  99780019900000      1603567616 0000_000000000_0000017      no /pnfs/cms/production/Federation_backups
    VO1983  99780054800000      1425899520 0000_000000000_0000018      no /pnfs/cms/production/Federation_backups
    VO1983  99780076000000      1261338624 0000_000000000_0000019      no /pnfs/cms/production/Federation_backups
    VO1983  99780099700000      1445068800 0000_000000000_0000020      no /pnfs/cms/production/Federation_backups
    VO1983  99780117500000      1068957696 0000_000000000_0000021      no /pnfs/cms/production/Federation_backups
    VO1983  99780137800000      1270415360 0000_000000000_0000022      no /pnfs/cms/production/Federation_backups
    VO1983  99780161700000      1607270400 0000_000000000_0000023      no /pnfs/cms/production/Federation_backups
```

Inhibits

The inhibits are listed on the page in the format `system_inhibit[0] - system_inhibit[1]`.
`system_inhibit[0]` can take any of the following values:

none	the normal state (no inhibits)
READONLY	volume is read-only
DELETED	volume has been deleted, but admins can still restore the metadata if the volume has not been reused.
NOACCESS	no access allowed (set by system to prevent further access to volume on which it found an error; once the problem is resolved the operator must clear the NOACCESS state or if the

	problem is not quickly resolvable they will set it to NOTALLOWED)
NOTALLOWED	no access allowed (set manually by the operator to prevent access to volume)

`system_inhibit[1]` can take any of the following values:

none	the normal state (no inhibits)
full	volume is full
migrated	files have been migrated to another tape
migrating	files are in the process of being migrated to another tape
duplicated	files have been duplicated to anther tape (mimicking the multiple copies feature of encp)
duplicating	files are in the process of being duplicated to another tape
cloned	files have been copied to another tape of the same media type
cloning	files are in the process of being copied to another tape of the same media type

9.9 Movers Page

What? The **Movers** page displays the current status of all the movers. (The mover statuses are described in section Error: Reference source not found.)

Why? Use this page to see how far into a job a mover is, or to check other job details related to the mover, e.g., what volume is being used for your job.

How? There are several paths to arrive at this page. The two easiest and most common are:

- On the top page click “Enstore Server Status”. Click on a mover.
- On the top page click “Enstore Server Status”. Choose a library manager to get to the **Library Manager Queues** page, then click on a mover.

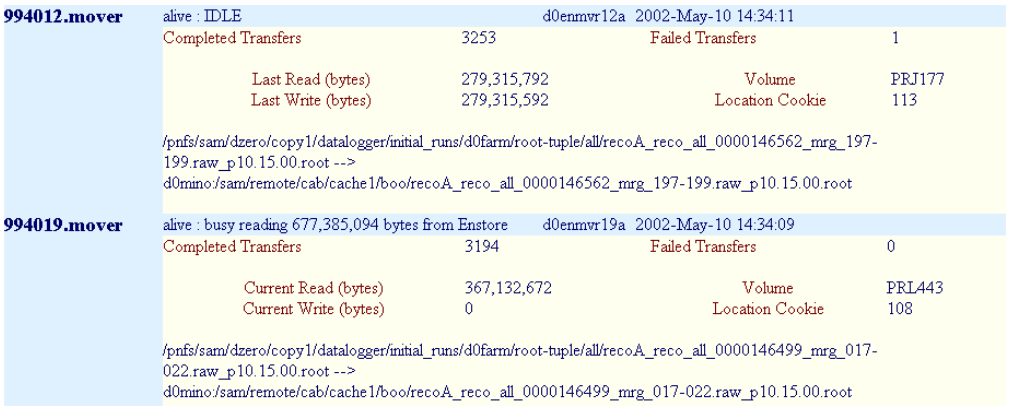
When you click on a specific mover, you are brought to the entry for that mover on the **Movers** page.

Page Description

This web page shows the most recent known state of all of the movers in the Enstore system. The first image (below) shows the field headings. The online help page provides a detailed description of the fields.

This next image shows movers that are busy mounting, seeking and writing tapes. The pnfs and user filenames are given as appropriate:

This image shows movers that are idle (awaiting a job), and busy reading a tape:



Understanding the Number of Bytes Read/Written

For a READ job,

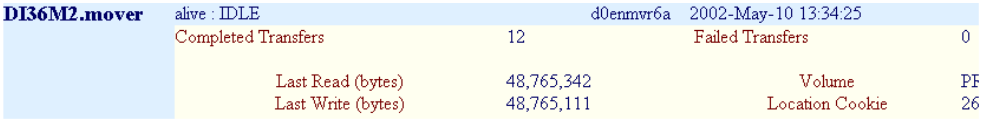
“Last/Current Read (bytes)”	means “bytes read from tape”
“Last/Current Write (bytes)”	means “bytes written to user’s file”

whereas for a WRITE job,

“Last/Current Read (bytes)”	means “bytes read from user’s file”
“Last/Current Write (bytes)”	means “bytes written to tape”

For jobs in progress, the number of “Current Read (bytes)” is by necessity

higher than “Current Write (bytes)”.
For finished jobs (e.g., of status IDLE or busy dismounting volume), you can compare “Last Read (bytes)” to “Last Write (bytes)” to tell if a job was a READ or WRITE. The file size is always bigger on tape than on the user’s disk because the file family wrapper is on the tape copy only. So for example, on a READ job, Enstore reads a larger file from tape and writes a smaller one to disk, and thus the “Last Read (bytes)” value is larger than “Last Write (bytes)” (as shown in image below). The converse is true for a WRITE job.



9.10 Encp History

What? This page lists the last several **encp** transfers that have completed, either successfully or with an error.

Why? Use this page to review recent **encp** transfers.

How? To arrive at the **Encp History** page, click “Encp History” on the top page or the **ENCP** button at the top of any page.

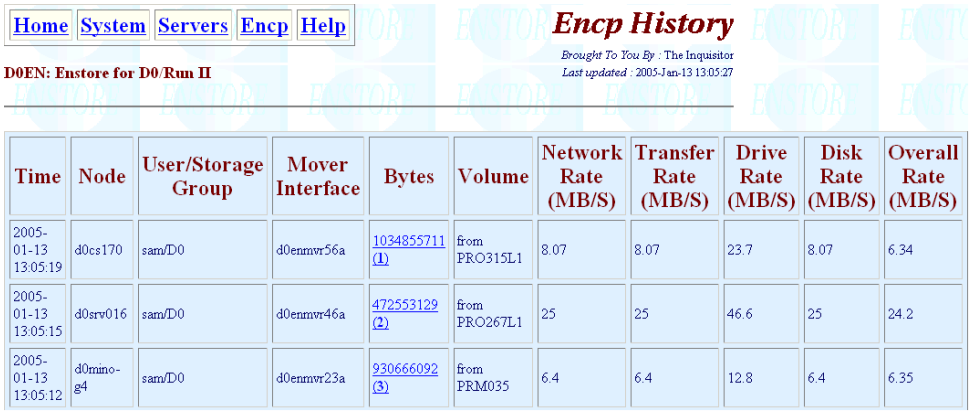
Page Description

On the **Encp History** page:

Successful transfers show — time that transfer completed, node, username and storage group, mover interface (the TCP/IP interface used on the mover node), bytes transferred, volume ID, and rates for network, transfer, drive, disk and overall (all in Mb/s). See section 6.5.3 *Encp Transfer Rates Defined*.

Unsuccessful transfers show — time of attempted transfer, node, username, storage group and error summary. Each error summary contains a link to a more detailed error message.

The top portion of the page is a table listing details of each recent transfer:



Home | System | Servers | Encp | Help

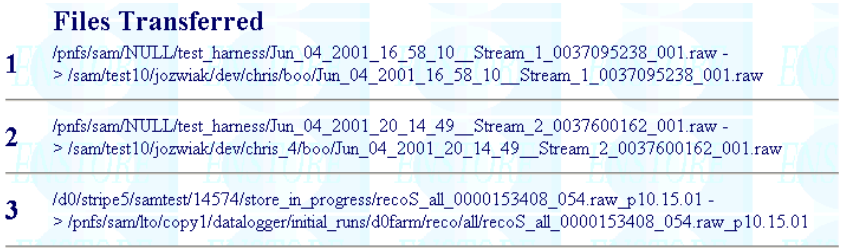
Encp History

Brought To You By : The Inquisitor
Last updated : 2005-Jan-13 13:05:27

D0EN: Enstore for D0/Run II

Time	Node	User/Storage Group	Mover Interface	Bytes	Volume	Network Rate (MB/S)	Transfer Rate (MB/S)	Drive Rate (MB/S)	Disk Rate (MB/S)	Overall Rate (MB/S)
2005-01-13 13:05:19	d0cs170	sam/D0	d0enmvr56a	1034855711 (1)	from PRO315L1	8.07	8.07	23.7	8.07	6.34
2005-01-13 13:05:15	d0srv016	sam/D0	d0enmvr46a	472553129 (2)	from PRO267L1	25	25	46.6	25	24.2
2005-01-13 13:05:12	d0mino-g4	sam/D0	d0enmvr23a	930666092 (3)	from PRM035	6.4	6.4	12.8	6.4	6.35

The value under *Bytes* provides a link to the *Files Transferred* area of the page which gives you the originating and destination file names:



Files Transferred

1 /pnfs/sam/NULL/test_harness/Jun_04_2001_16_58_10__Stream_1_0037095238_001.raw -
> /sam/test10/jozwiak/dev/chris/boo/Jun_04_2001_16_58_10__Stream_1_0037095238_001.raw

2 /pnfs/sam/NULL/test_harness/Jun_04_2001_20_14_49__Stream_2_0037600162_001.raw -
> /sam/test10/jozwiak/dev/chris_4/boo/Jun_04_2001_20_14_49__Stream_2_0037600162_001.raw

3 /d0/stripe5/samtest/14574/store_in_progress/recoS_all_0000153408_054.raw_p10.15.01 -
> /pnfs/sam/lto/copy1/datalogger/initial_runs/d0farm/reco/all/recoS_all_0000153408_054.raw_p10.15.01

At the very bottom of the page, you can find the errors in red, if any:

9.11 Configuration

What? The **Enstore Configuration** page shows the Enstore system's current configuration.

Why? This page is for administrators. But if you want configuration information on any component in the Enstore system, you can look here. For example:

- If you see a server listed as unmonitored (in grey) on the **Enstore Server Status** page, you can verify its status here (if the element `inq_ignore` appears, the server is unmonitored).
- If you want to check the log files for activity related to a particular mover, look here for the `logname` value associated with the mover, then search the log files for that string.

How? To arrive at the **Enstore Configuration** page, click “Configuration” on the top page.

Page Description

The page is divided into two sections:

- The first section provides a quick link to each of the servers listed in the table in the second section.
- The second section, is a (potentially quite long) table containing detailed configuration information for all of the Enstore servers. For each server, there is a table row for each element that appears in the server’s configuration. The information displayed includes the element name and its current value. No interpretation of the values is done, so for instance if the value is a python dictionary, then it is presented here as such. The server names, and under them the element names, are organized alphabetically.

This image shows the top of the table in the second section on the **Enstore Configuration** page, including the (truncated) entry for one of the system’s movers:

Server	Element	Value
994004.mover	check_written_file	30
	compression	0
	data_ip	d0enmvr4a
	device	/dev/rmt/tps0d1n
	dismount_delay	10
	do_cleaning	No
	driver	FTTDriver
	host	d0enmvr4a
	hostip	131.225.164.27
	library	mezsilo.library_manager
	logname	BED4MV

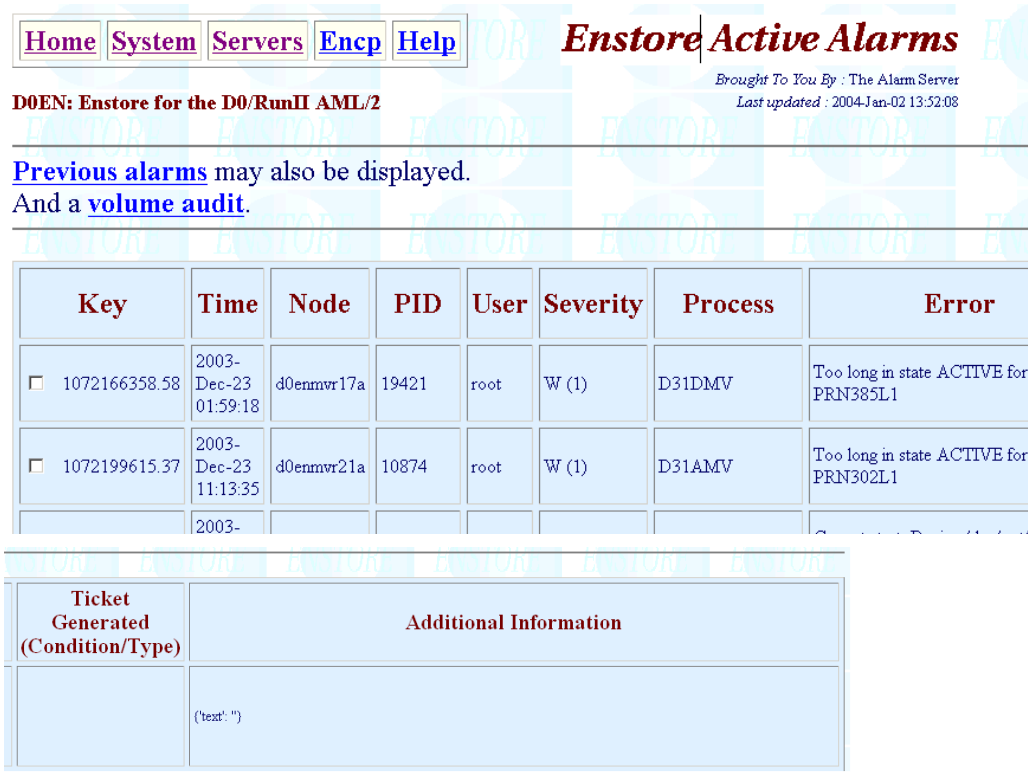
9.12 Enstore Active Alarms

What? The **Enstore Active Alarms** page lists the alarms that have been raised but not yet resolved.

Why? This page is for administrators, but as a user, you can always look here for information when there is a problem with Enstore. In particular, if a volume is set to NOACCESS, you can look here to find out which mover was involved.

How? To arrive at the **Enstore Active Alarms** page, click "Alarms" on the top page.

The page is quite wide; we show first the left side, then the right.



9.13 Enstore Log Files

What? The **Enstore Log Files** page provides links to Enstore system-specific user log files and to standard Enstore daily log files. You can search log files or retrieve entire log files.

Why? This page is for administrators. You can use the log files to retrace Enstore activity, to understand Enstore problems or behavior, and so on.

How? To arrive at the **Enstore Log Files** page, click "Log Files" on the top page.

There are three sections to the **Enstore Log Files** page.

Link to Search Page

First there is a link to a search page; look for "Enstore log files may also be *searched*". Use the **HELP** button for information on constructing your search string. (Shown in the image below.)

User Specified Log Files

The next part is entitled *User Specified Log Files*. It lists miscellaneous log files configured and maintained for your Enstore system.

Any given Enstore installation may contain some or all of these log files:

FAILED Transfers	Lists all **encp** jobs that failed; lists by volume and by mover
Recent (robot) log messages	Displays all the messages from the robot (for the most

	recent few days)
Active Monitor Log	Displays the data transfer rate between the base node and all other nodes in the same Enstore system, including movers
Cambot (D0)	Displays a live image photographed by a camera mounted inside the D0 ADIC robot
Enstore Node Information	Displays information on all nodes belonging to this Enstore system.
Network-At-A-Glance	Displays network interface status of all nodes relative to base node; uses colored icons for easy identification of problems
PNFS Export List	Lists all the existing PNFS areas for the Enstore system (when PNFS is mounted, these are the areas that get NFS-mounted)

Enstore Log Files

The bottom portion of the page is called *Enstore Log Files*. It displays a calendar of the current (and possibly the previous) month from which you can click the date of the log file to view (the image below was captured on January 2, 2004, the last date that shows an entry). The size of the log file is given.

 Requesting a day's log file is memory intensive and very slow due to the large size of the log file.

9.14 Quota and Usage

What? The **Quota and Usage** page provides information on your Enstore volume usage, organized by library and by storage group. The page is not real-time, it displays a recent snapshot.

Why? Administrators and users can look here to see a variety of details about your Enstore system's resource and quota management.

How? To arrive at the **Quota and Usage** page, click "Quota and Usage" on the top page.

This page displays the following fields:

Library	library manager
Storage Group	storage group
Req. Alloc.	requested volume (e.g., tape) allocation
Auth. Alloc.	authorized volume allocation
Quota	total space allowed in robot
Allocated	total number of volumes currently allocated in the robot
Blank Vols	of the allocated volumes, the number that are blank
Used Vols	of the allocated volumes, the number that are written
Deleted Vols	of the allocated volumes, the number that have been deleted
Space Used	total space used on all allocated volumes
Active Files	total number of active (non-deleted) files on all allocated volumes
Deleted Files	total number of deleted files on all allocated volumes
Unknown Files	

9.15 Enstore Plots

What? The **Enstore Plots** page provides information on Enstore performance in a visual format. These are not real-time, they are snapshots.

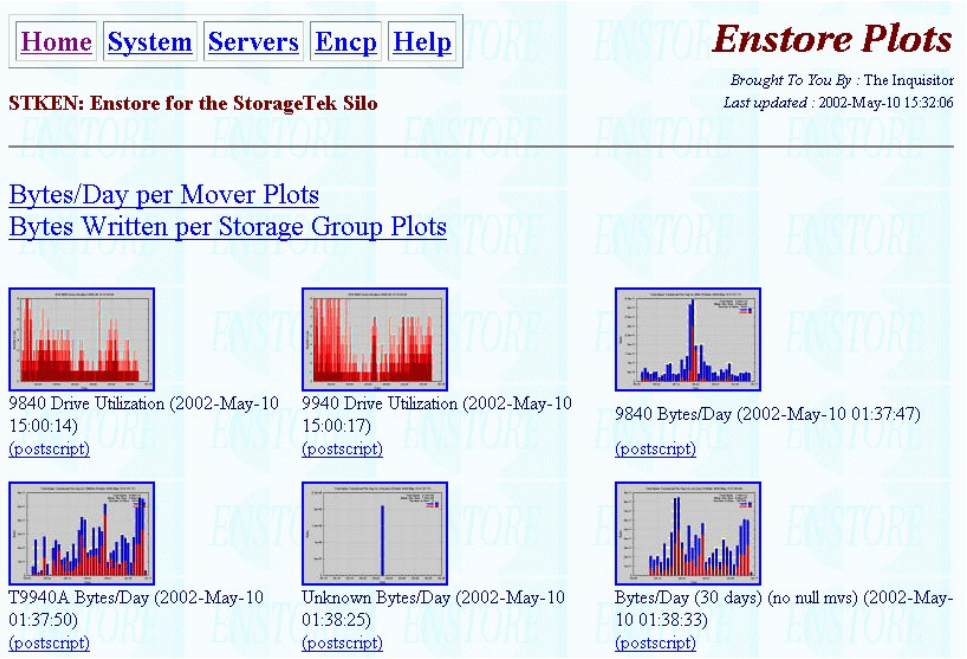
Why? You can look here to see a variety of details about your Enstore system's recent performance.

How? To arrive at the **Enstore Plots** page, click "Plots" on the top page.

The **Enstore Plots** page, provides information on some statistics that Enstore gathers. These statistics are gathered from the log files produced by Enstore. Several plots are available:

- Drive Utilization
- Bytes/Day Plot
- Bytes/Day per Mover Plot
- Mount Latency Plot

- Mounts/Day per Drive Type
- Storage group activity (STKEN only)
- Total bytes/Day
- Total bytes/Day combining all three systems (D0EN, CDFEN, STKEN)
- Total bytes written/Day
- Cumulative Mounts Plot
- Transfer Activity (log) Plot
- Transfer Activity Plot
- Mounts/Day Plot
- Null Terabytes/Day (Instantaneous Rate Plot)
- Real Terabytes/Day (Instantaneous Rate Plot)



All the plots are described in the online help page. Each plot is available for viewing three ways:

- a small version of the plot (postage stamp) displayed directly on the page
- a full size version of the plot; click on the postage stamp to display
- a postscript copy of the plot; click on the (postscript) link to display

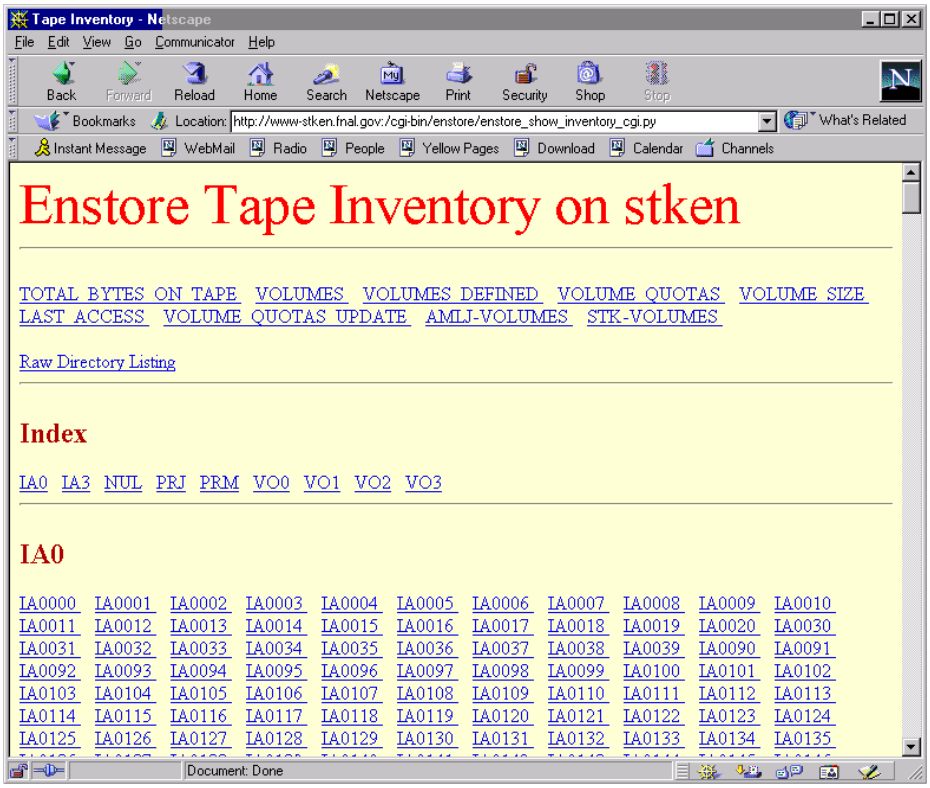
9.16 Tape Inventory Page (Dynamic HTML)

What? For each volume declared to your Enstore system you can dynamically (re)create a page that presents its volume inventory information in HTML format.

Why? Use this page to find out details of the storage of your file(s) on a volume, to see how full a tape is, or to check the inhibits.

How? To arrive at this page start at the top page, scroll down to the *Information* table, and click “Tape Inventory”. This brings you to a list of all declared volumes in your Enstore system. Click on the volume of interest.

This page is dynamic and uses a lot of server time; please minimize the number of times you regenerate this page.



Find the volume of interest and click it to get a file listing. The format is essentially identical to that shown in sectionError: Reference source not foundError: Reference source not found, but in addition under the heading, you get a list of volume parameters:

```
{'blocksize': 131072,
'capacity_bytes': 107374182400L,
```

```
'comment': '',
'declared': 'Thu Jul 25 15:27:27 2002',
'eod_cookie': 'none',
'external_label': 'IFA001L1',
'first_access': 'Wed Oct 23 12:42:43 2002',
'last_access': 'Fri Nov 8 10:43:08 2002',
'library': 'samlto', 'media_type': '3480', 'remaining_bytes': 107374182400L,
'si_time': ('Fri Dec 6 10:22:41 2002', 'Wed Dec 31 18:00:00 1969'),
'sum_mounts': 2,
'sum_rd_access': 0,
'sum_rd_err': 0,
'sum_wr_access': 0,
'sum_wr_err': 0,
'system_inhibit': ['none', 'none'],
'user_inhibit': ['none', 'none'],
'volume_family': 'd0backup.d0backup_30.cpio_odc',
'wrapper': 'cpio_odc'}
```

Chapter 10: Job Priority and Queue Management

Users submit read and write jobs to **encp** (often through an interface, e.g., dCache). **Encp** sends a request for each job to an Enstore library manager for processing. The library manager receives these requests, stores them in a queue, assigns a priority to each one, and passes them to a mover for actual data transfer. A request's priority determines when it will get processed relative to others in the queue, and its priority may change as circumstances change while it waits in the queue. There are four items that factor into determining priority: category, numerical value within the category, "Fair Share", and ownership of resources by a group/experiment.

10.1 Job Priority Categories

There are two categories of job priority: normal and DAQ/Admin. The default priority is "normal". DAQ/Admin priority, as its name implies, is reserved for high-priority jobs.

DAQ/Admin priority is granted only to job requests that satisfy certain preconfigured conditions. Conditions, if set, filter on the request's originating username, group, node, and so on. For example, conditions could be set to grant DAQ/Admin priority to all jobs submitted by user *joe* from node *mynode1*, by users *george* or *kim* from any node, and by any user from node *myspecialnode*; all other jobs get normal priority.


Setting conditions for DAQ/Admin priority is an administrative function.

Requests that get submitted and receive DAQ/Admin priority get moved to the head of the LM's request queue. If there is more than one at a time, the other priority-related factors determine the order in which these requests get processed. Any normal priority transfer that is in progress is allowed to complete, but the system does not then process other normal priority requests in the queue that are waiting for the same volume. At the completion of the current transfer, the tape is replaced in the drive if necessary, then the (first) DAQ/Admin request gets processed.

10.2 Numerical Priority Values

Within its priority category, each request is also assigned an initial numeric priority value. The numeric priority is set by default according to preconfigured conditions. It can be overridden on the command line using the **encp** options described in section 6.6 *Encp Command Options*, although we

strongly recommend against doing this. The numeric priority may change while the request waits in the queue depending on (a) the **encp** options used, (b) the elapsed time in the queue.

10.3 Fair Share Resource Allotment

Enstore queue management has an algorithm called “Fair Share”, that helps to keep any one storage group (experiment or group) from monopolizing tape drives.
When a mover which does not have a mounted tape asks the Library Manager for the next request, the Fair Share determines which storage groups currently have requests in progress (at a mover) and which ones don’t, then gives preference to requests associated with those that don’t. This helps ensure that there is a fair distribution of resources available to all groups currently using the system.

10.4 Resource Ownership

When an experiment or group purchases one or more tape drives, the drives go into the pool of Enstore resources, accessible by all users, with the recognition that the purchasing group has preferential access to this number of drives. The Fair Share configuration (section Error: Reference source not found) gets modified to guarantee this access. The priorities of other requests in the queue may be perturbed when Enstore needs to free up one or more tape drives for jobs submitted by the purchasing group.
In contrast to DAQ/Admin requests, these (normal priority) requests, identified by their storage group, must wait until a tape has dismounted in the normal way before being processed. A tape normally dismounts after all requests in the queue requiring that tape have completed.

Appendix A: Network Control

This appendix discusses the control of ethernets on client systems when the client interacts directly with Enstore via encp, as opposed to interacting with the dCache as a front-end.

A.1 Default Routing for Encp

By default, **encp** uses the DNS name obtained by the `hostname` command for control messages. **Encp** uses whatever routing the client system or network administrator sets between the client system and the Enstore system for data transfers.
Typically, the default configuration suffices for machines having a single network interface, or having a single network interface dedicated to data movement.

A.2 Routing via the enstore.conf file

For large client machines with multiple network connections (interfaces), each network interface is attached to a different (virtual) router. A one-to-one mapping is made between the IP address of each interface and the IP of the router it is attached to. The Computing Division's networking group must perform the configuration for this.
Administrators can create an `enstore.conf` file to configure the routing to allow for multiple network interface cards dedicated to Enstore, and/or to allow for a different IP address to be used for the **encp** control socket. The default location for the file is `/etc/enstore.conf`. The location of the file can be overridden with the environment variable ENSTORE_CONF.
The file format supports comments, a host ip line, and zero or more interface lines (all these line types are optional).

Comment Lines

Comment lines begin with a "pound" sign, "#", e.g.,:

```
# this is s comment line
```

Hostip Line

The `hostip` line gives the host IP address used to override the DNS name that **encp** uses to `bind(2)` with. This is used when doing a (passive) open on a socket used to listen for a call back from the mover. One and only one hostname line is necessary per `enstore.conf` file. For example:

```
hostip=131.225.42.42
```

Interface Lines

Lines starting with `interface` are used in this file to specify more than

one network interface for data transfers. An `enstore.conf` file would typically contain either zero or at least two of these lines, since a single interface can be controlled more conventionally with static routes.
This functionality is known to work on IRIX and Linux machines. It has not been tested on SunOS or OSF1, although it is expected to work.
The underlying implementation mechanisms for multiple interfaces are portable, and the scheme can be extended on demand. When more than two interfaces are used, it is necessary to have each interface on its own subnet. (The system or network administrator needs to configure the subnets.) The enroute2 executable (part of the **encp** product) must be installed and have setuid root on the machine in order to enable this feature.
In order for the interface lines in the `/etc/enstore.conf` to be used:

- an executable named `enroute2` needs to be in **encp**'s path.
- `enroute2` must have the setuid bit turned on.
- `enroute2` must be owned by root.

The `enroute2` utility is included with the **encp** product from **UPS/UPD**, but the setuid bit is not set by default. The search path for this executable with the setuid bit set is:

1. $ENROUTE2
2. $ENCP_DIR/enroute2
3. $ENSTORE_DIR/sbin/enroute2
4. /usr/local/bin/enroute2
5. /etc/enroute2

An `interface` line must specify four keywords (with an optional fifth for IRIX):

- `interface` specifies the network device.
- `weight` specifies the relative capacity of each interface. For example, if 1 Gb/s and 100 Mb/s interfaces are used, they might be assigned weights of 30 and 10, respectively.
- `ip` specifies the ip address corresponding to the device given by `interface`.
- `gw` specifies the ip address corresponding to the gateway to the Enstore movers for the device given by `interface`. (Get this information from the networking admins.)
- `cpu` The `cpu` keyword is used on IRIX systems only. Its use is desirable for minimizing the amount of CPU used per transfer, though it is technically not required. The performance enhancements will take effect if two conditions are met: If the CPU used by **encp** has hardware affinity with the slot holding the network card, and if the same CPU performs interrupt service for the network card.

For example, a file may contain two `interface` lines as follows:

```
interface=eg2 weight=100 cpu=2 gw=131.225.32.32 ip=131.225.32.31
interface=eth1 weight=10 cpu=3 gw=131.225.32.36 ip=131.225.32.35
```

Appendix B: Changing PNFS Tags

B.1 Caveat

Tags (i.e., tag values) can be changed if the standard UNIX permissions on them allow for it. However, thought and planning should go into structuring the storage of an experiment's data, and users should not change any tags without consulting the people in their experiment responsible for this task. The storage group tag cannot be changed by users.

B.2 Permissions and Ownerships

 This is typically done by your experiment's Enstore liaison. Most users do not have permissions to change permissions and ownership.
The permissions shown in the output of the **`enstore pnfs --tags`** command (see section 4.3.2 *How to View Tags*) indicate whether you can change the value of the tag or not. To change a tag, you need to use the **`enstore pnfs`** command with one of the options **`--tagchown`** or **`--tagchmod`** to change ownership or permissions, respectively (see section 9.4 *enstore pnfs*).
For example, to add write permission for "other" to the permissions for the file family tag, you'd enter (include the quotes):

```
% enstore pnfs --tagchmod o+w file_family
```

or you can use the absolute form for the mode, e.g.,

```
% enstore pnfs --tagchmod [0]646 file_family
```

To change the ownership, run a command like either of the following, using userid or userid.groupid, or any associated combination:

```
% enstore pnfs --tagchown xyz file_family

% enstore pnfs --tagchown xyz.g023 file_family
```

B.3 How to Set a Tag

To set one or more tags on a directory, **`cd`** to that directory and run the **`enstore pnfs`** command with the option for the tag you want to reset. It is ok to change tags on a directory into which files have already been written; Enstore will still be able to find the files.
These operations are for Enstore admins or designated gurus only; the commands succeed only if permissions allow.

--file-family <FILE_FAMILY_NAME>

If permissions allow, this will reset the file-family name of the current pnfs directory to the specified value. Example:

```
$ enstore pnfs --file-family newfamilyname
```

--file-family-width <FILE_FAMILY_WIDTH>

If permissions allow, this will reset the file-family width of the current pnfs directory to the specified value. Example:

```
$ enstore pnfs --file-family-width 2
```

--file-family-wrapper <FILE_FAMILY_WRAPPER>

If permissions allow, this will reset the file-family wrapper of the current directory to the specified value. Example:

```
$ enstore pnfs --file-family-wrapper cpio_odc
```

--library <LIBRARY>

Provides a name to reset the library tag. Example:

```
$ enstore pnfs --library mylib
    [Errno 13] Permission denied: '/pnfs/test/xyz/srmtest/test_1_1/.(tag)(library)'
```

Run the **`enstore pnfs --tags`** command to see the changes you make; see section 9.4 *enstore pnfs*.

Enstore Glossary

accounting server
: This server maintains statistical information on a running system. It is Enstore's interface to a database of transfer-related data.

active file
: Any file in Enstore that is not deleted.

alarm server (AS)
: The Alarm Server maintains a record of alarms raised by other servers, and creates a report that's available online.

bfid
: Bit file id; an Enstore-assigned, unique identifier for a data file.

cern wrapper
: A file family wrapper that accommodates data files up to (10^21 – 1) bytes. It matches an extension to the ANSI standard, as proposed by CERN, and allows data files written at Fermilab to be readable by CERN, and vice-versa. See **file family wrapper**.

configuration server (CS)
: The Configuration Server maintains and distributes the information about Enstore system configuration, such as the location and parameters of each Enstore component and/or server.

cpio_odc wrapper
: A file family wrapper which allows the file to be dumpable via cpio. This wrapper has a file length limit of (8G – 1) bytes. See **file family wrapper**.

crc (Cyclic Redundancy Check)
: Used to verify that data has been stored properly; it's used like a checksum, but is less prone to multiple-bit errors. During a transfer, both sides calculate the crc and compare the values, unless the `--no-crc` option is specified. Enstore uses a one seeded Adler 32 crc by default. Enstore at Fermilab uses a zero seeded Adler32 crc.

cwd
: current working directory

dCache
: DCache is a data file caching system which acts as an intelligent manager between the user and the data storage facilities. It optimizes the location of staged copies according to an access profile. It decouples the (potentially slow) network transfer rate from the (fast) storage media I/O rate in order to keep the mass storage system from bogging down.

dCap
: **DCap** is a dCache-native C-API access protocol. The **dCap** package comprises the commands dcap, dc_check and dc_stage.

dc_check

A **dCap** command which checks if a file is on disk in the dCache.

dccp

A **dCap** command which provides a **cp**-like functionality on the PNFS file system.

dc_stage

A **dCap** command which prestages a read request.

ddencp

A command packaged with **encp** which copies a local file to another local file.

DESY

Deutches Elektronen-SYnchrotron; a laboratory in Hamburg, Germany that conducts particle physics research.

direct I/O

Direct I/O differs from normal disk read/writes in that it by-passes the file system's buffer cache. This is achieved by skipping the (normally done) copy that goes from the application memory space to the kernel buffer's memory space. Direct I/O is an SGI/Linux extension. Compare to **memory-mapped I/O** and **POSIX I/O**.

door (for dCache)

A door is a protocol converter (e.g., for FTP, dCap) between clients and internal dCache systems. Each door is associated with a particular port on the dCache server, and has its own access profile.

drivestat server

The drivestat server maintains statistical information of the drives.

ecrc

Stands for Enstore crc (cyclic redundancy check); see **crc**. **ecrc** is a command packaged with **encp** which calculates the crc of a local file.

en_check

A command packaged with **encp** which determines if a file is on tape.

encp

Encp as an end-user command is considered to be deprecated. It was designed to be used with Enstore, and used to copy data files from disk to storage media and vice-versa. This command is distributed as part of the **encp** product, available from kits under `ftp://fnkits.fnal.gov:8021/products/encp/` or `ftp://fnkits.fnal.gov:8021/KITS/<OS>/encp/`, e.g., `ftp://fnkits.fnal.gov:8021/KITS/Linux/encp/`

The **encp** product also includes three diagnostic tools: **ecrc**, **ddencp**, **en_check**.

Enstore

Enstore is the mass storage system implemented at Fermilab as the primary data store for experiments' data sets. It provides distributed access to data on tape or other storage media both locally and over networks.

enstore.conf

A configuration file to allow for multiple network interface cards dedicated to Enstore, and to map the interfaces to routers. The default location for the file is

`/etc/enstore.conf`. The location of the file can be overridden with the environment variable ENSTORE_CONF. See **ENSTORE_CONF**.

ENSTORE_CONF
: Environment variable that can be used to override the location of the `enstore.conf` file. See **enstore.conf**.

ENSTORE_CONFIG_HOST
: An environment variable which points to the Enstore server that is running the configuration server

ENSTORE_CONFIG_PORT
: An environment variable which sets the port number; the value is (by convention) 7500 for all installations at Fermilab.

ensync
: A wrapper for **encp** that allows you to copy the contents of an entire directory structure to Enstore via a single command.

event relay (ER)
: The Event Relay is a server that forwards messages based on subscription. All the Enstore servers send messages to the ER. Any server may "subscribe" to the ER in order to have messages of particular types forwarded to it.

fairshare
: A mechanism used in Enstore's queue management that helps to keep any one storage group (experiment or group) from monopolizing tape drives. Fairshare determines which storage groups currently have jobs in progress (at a mover) and which ones don't, then gives preference to requests associated with those that don't.

file clerk (FC)
: The File Clerk is a server that tracks files in the system. It manages a database of metadata for each data file in the Enstore system.

file family
: A file family is a grouping of data; it defines a category, or family, of data files. Each experiment defines a set of file families for its data. A given storage volume may only contain files belonging to one file family.

file family width
: File family width is a value used to limit write-accessiblity on data storage volumes. At any given time, Enstore limits the number of volumes associated with a given file family that are open for writing to the value of the file family width.

file family wrapper
: A file family wrapper consists of information that gets added to the front and back of data files as they're written to media, and defines the files' format on the storage volume. The format of the wrapper depends on the type of wrapper used. (See **cern wrapper** and **cpio_odc wrapper**.)

filemark
: A filemark is a physical mark on tape indicating end of file. Tape drives recognize it and can do high speed searches over it.

ftp

File transfer protocol.

gridftp

See **GSI ftp**.

GSI ftp

An implementation of ftp that uses Grid Proxies for authentication and authorization and is compatible with popular tools such as globus-url-copy (from the globus toolkit).

information server

A read-only server that maintains detailed file and volume information.

inquisitor

The Inquisitor monitors the Enstore servers, obtains information from them, and creates reports at regular intervals that can be viewed on the web.

job

In Enstore terminology, a job is what a user submits to **encp**. See **request** for comparison.

Kerberized ftp client

A Kerberized ftp client is an ftp client that implements Kerberos v5 authentication.

layer

Pnfs stores metadata about each file in “layers”, each layer containing a specific type of metadata. Each stored data file has its own set of these layers. Currently, only layers 1 and 4 are used.

library

A library in Enstore is comprised of both the physical data storage media, robotic devices and drives. An Enstore library is typically called a robot.

library manager (LM)

A Library Manager is a server which controls a virtual library. LMs receive requests for file copies from users via **encp** and they distribute the requests to the Movers.

log server (LS)

The Log Server (LS) receives messages from other processes and logs them into formatted log files that are available online.

media changer (MC)

The Media Changer mounts and dismounts the media into and out of drives according to requests from the Movers.

memory-mapped I/O (mmapped I/O)

With this type of I/O, part of the CPU's address space is interpreted not as accesses to memory, but as accesses to a device; once you map a file to memory, changes made to the memory map are propagated back to the file. Mmapped I/O strives to avoid memory copies of the data between the application memory space and the kernel memory space (also see **direct I/O** and **POSIX I/O**). Mmapped I/O is in the POSIX standard.

monitor server (MS)

The Monitor Server is available for investigating network-related problems. It attempts to mimic the communication between an **encp** request, the corresponding library manager, and the mover.

mover (MV)

A Mover is a process responsible for efficient data transfer between the **encp** process and a single, assigned media drive in a library (robot). The Mover receives instructions from a Library Manager (LM) on how to satisfy the users' requests. The Mover sends instructions to the Media Changer (MC) that services the Mover's assigned drive in order to get the proper volume mounted.

null wrapper

A file family wrapper for NULL volumes. See **file family wrapper**.

pnfs layer

See "layer".

pnfs namespace

Pnfs is an independent namespace package, written at DESY. It presents a collection of library database entries as a UNIX-like file system, and thus allows users to browse stored files as though they reside in this file system. Pnfs is mounted like NFS, but it is a virtual file system only. It maintains file grouping and structure information via a set of tags in each directory.

pnfs tags

See tags.

POSIX I/O

POSIX is a name applied to a widely used family of open system standards based on UNIX. POSIX I/O refers to the POSIX standards for I/O.

request

In Enstore terminology, after a user submits a job to **encp**, **encp** sends a request to Enstore to process the job. See **job** for comparison.

resubmit

Encp has functionality to retry and resubmit requests, where we distinguish between these two terms. **Encp** will *resubmit* a request if it has been waiting for a mover for over 15 minutes, but not due to an error condition. See **retry**.

retry

Encp has functionality to retry and resubmit requests, where we distinguish between these two terms. **Encp** will *retry* (i.e., resend) a request after an error occurs. See **resubmit**.

SRM

SRM (Storage Resource Management) is the middleware for managing storage resources for the grid.

storage group

A storage group is an identifier corresponding to an experiment that Enstore uses as it controls and balances assignment of resources such as tape drives and media. Each storage group (i.e., each experiment) is assigned an area in PNFS.

storage volume

A unit of mass storage, e.g., a tape.

streaming (of files on tape)

Streaming refers to the sequential access of adjacent files on tape at the maximum tape read/write speeds.

striping (of files on tape)

Striping refers to single files (usually large ones) being split onto two or more volumes, each writing simultaneously, in order to expedite the writing process. (Striping is not supported under enstore.)

suspect volume

A volume becomes suspect when a mover communicates to the appropriate library manager that it had a problem with the volume. It is not yet established that the volume is faulty.

tags

Pnfs uses tag files (usually just called tags) in the `/pnfs` namespace to specify file-specific configuration information, and **encp** transfers this information to Enstore. Tags are associated with directories in the `/pnfs` namespace, not with any specific file, and thus apply to all files within a given directory.

virtual library

A Virtual Library (VL) is a subset of an Enstore data storage library. It can contain one and only one type of media. It is paired with its own library manager which controls it.

volume

See storage volume.

volume assert

A job in which a volume (tape) gets mounted and certain attributes are read in order to check, and thus assert, that the volume is “ok” (without actually checking the entire contents). Requesting volume asserts is an administrative task, and these requests are assigned the lowest priority.

volume clerk

The Volume Clerk (VC) is a server that stores and administers storage volume (tape) information.

volume family

The triplet “storage group + file family + file family wrapper” is called a volume family. In order for different data files to be stored on the same volume, all three of these pnfs tags for the files must match.

wrapper

See file family wrapper.

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